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Technical Report 472

EARLY FORMULATION OF TRAINING PROGRAMS FOR COST EFFECTIVENESS ANALYSIS

C.C. Jorgensen and P.L. Hoffer

ARI FIELD UNIT AT FORT BLISS, TEXAS

U. S. Army

Research Institute for the Behavioral and Social Sciences

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The need to assess the impact of training on system life cycle impacts has led to the development of cost and training effectiveness analysis (CTEA). This decision making strategy assumes a methodology by which the required support information can be generated. This report presents a CTEA technique for projecting media, method, and program efficiency prior to the development of well specified task lists. The report should be of particular interest to training analysts who are looking for a projection technique that can be specific enough to

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) generate recommended training hardware and yet flexible enough to accomodate new CTEA technology and lessons learned from field performance.

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FOREWORD

The research reported here is part of a broader program on air defense weapon systems being conducted by the Army Research Institute Field Unit at Fort Bliss, Tex. Since 1975, the Fort Bliss Field Unit has been engaged in a vigorous program of research to discover the methods, procedures and data available for conducting cost and training effectiveness analyses (CTEA). An especially challenging issue is the development of a methodology applicable to weapon systems still in the formative or conceptual stage of development.

The methodology presented in this report begins with preliminary duty or task description lists that include probable weapon characteristics. The methodology then utilizes a series of selection procedures to generate a profile of equipment and methods that could be used to train the tasks. The selection procedures also yield an efficiency ratio that indicates the relative opportunity costs of making alternate training decisions and assumptions. The final projected training requirements are formulated to be costed in dollars via a computer program.

While the methodology was developed with a view toward application on the many new air defense systems projected for fielding in the mid-80's, it is by no means restricted to air defense application. The methodology is intended for use in any man-machine system for which early estimations of cost and training effectiveness are required.

The entire program is responsive to the requirements of RDTE Project 2Q763743A771 and the Director of Training Developments, U.S. Army Air Defense School, Fort Bliss, Tex.

Joseph Zeidner

JOSEPH ZEIDNER
Technical Director

EARLY FORMULATION OF TRAINING PROGRAMS
FOR COST EFFECTIVENESS ANALYSIS

BRIEF

Increased accuracy in early budgetary prediction has become more important in recent years and has led to a corresponding need within all branches of the military services to better estimate future training programs and their impacts. Recent examples of this need have included the interservice procedures for instructional system development[1] (ISD), TRADOC Pamphlet 71-10,[2] and the Army Training Study.[3]

The need to assess the value of training programs and weapon systems has also led to the development of cost and operational effectiveness analysis (COEA) and associated analyses, such as cost and training effectiveness analysis (CTEA) and reliability, availability, and maintainability analysis (RAM). Each decision making tool, however, assumes a methodology by which the required information can be generated. In CTEA the methodologies are still in the developmental stages as a result of both instructional decision making and the current state of the art in training analysis. This paper addresses the latter area. Its concern is with developing a user-oriented procedure for early formulation of training programs that can be input into cost and training effectiveness analyses.

The research reported in this paper begins with a theoretical discussion of the procedure and proceeds to the specific. The first section (Section A) deals mainly with the underlying logic used in constructing the procedure. The discussion becomes more applied in Section B. Finally, in Section C a simplified example is presented designed to show how the procedure would function to choose a sample training method and its support equipment.

An overview of the procedure is shown in the flowchart in Figure 1. Each box in the flowchart corresponds to a key process that must be performed to formulate a future training program. Four of these processes: Choose media, record efficiency, describe functional context, and select a group method are considered in detail. The remaining boxes are discussed only in enough detail to illustrate how the processes work together for input into CTEA.

The starting point for this procedure is a task description. Much of the initial task analysis information for developing weapon systems is not available in the suggested Instructional Systems Development (ISD) Handbook format. Thus, the method in this paper has not been made dependent upon any particular task format, but instead recodes task information into a set of descriptive variables. CTEA processes are, therefore, defined in terms of interactions among these variables. Four separate variable matrices have been generated to select training media and methods. Each matrix corresponds to some function of a training program. The four matrices include: (1) The stimulus media (equipment/materials) presenting the training information, (2) the response media (equipment/materials) accepting the responses made by the student to the stimulus information, (3) the feedback media (equipment/materials) performing evaluations of the student response, and (4) the method, i.e., the organizational structure of student-instructor interrelationships, within which the media are used.

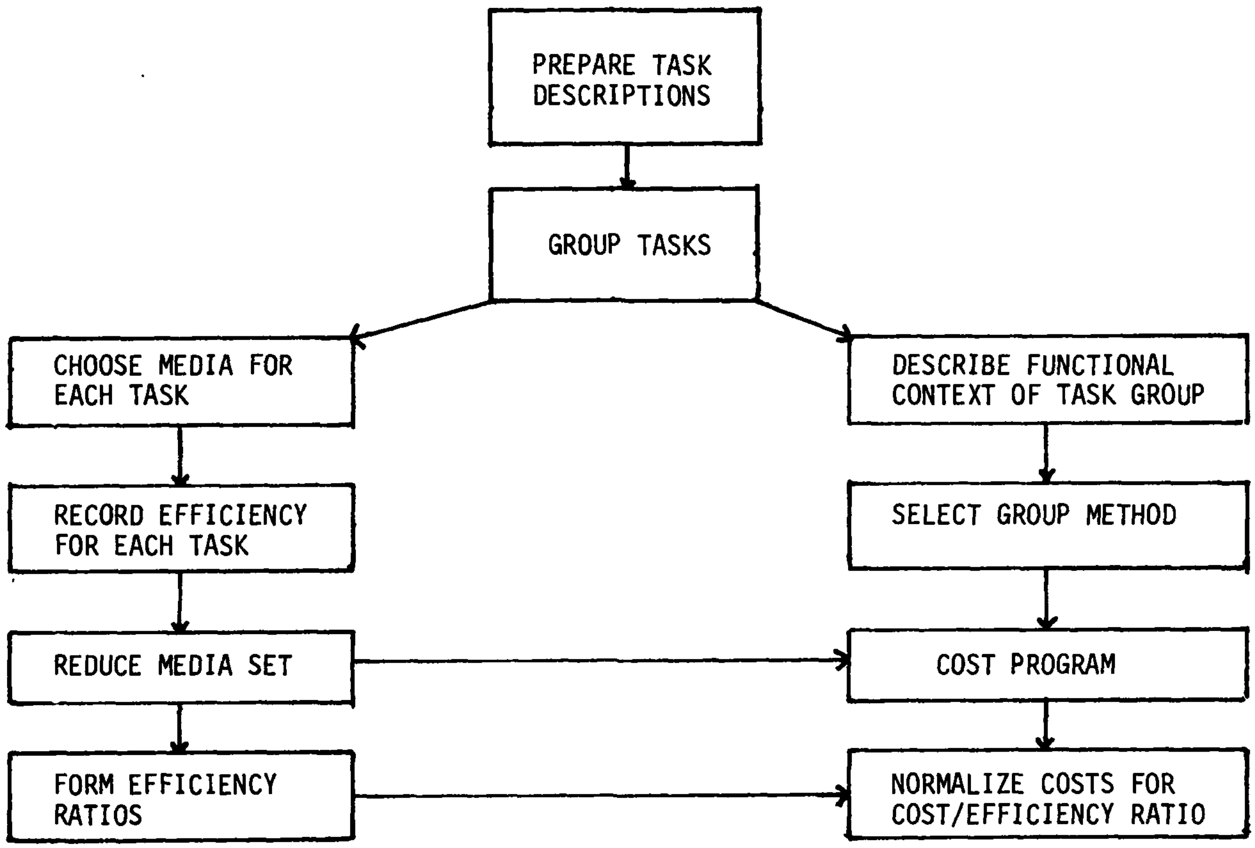

Figure 1. System formulation.

In the three media matrices, physical information derived from each task description is used to select an "ideal" piece of training equipment. This physical information is derived not only from the task description but also from the referenced characteristics of the system hardware upon which the task is performed.

Unlike the media matrices where physical information and system hardware derive the selection of stimulus, response, and feedback equipment, the training method matrix is based on variables which describe operational context. Because most of the commonly used methods are loosely defined, a separate procedure is used to more precisely define alternative training approaches.

Although the method and media variables aid training program selection decisions, a technique is also required to monitor effects produced by managerial changes. This paper presents a process called "efficiency ratio calculation" to track the psychological training gains or losses caused by program modifications. A costing process to track dollar values is also considered. Both measures comprise a cost/efficiency ratio which can be used by the CTEA analyst to compare the relative merits of various training programs.

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FOR COST EFFECTIVENESS ANALYSIS

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I. TECHNICAL SUPPLEMENT

A. THE LOGIC OF GOING FROM TASK DESCRIPTION TO TRAINING PROGRAM

To go from a task description to a costed training program, a procedure needs to be set up for defining the output (the training program elements) in terms of a series of manipulations on the input (task analysis data). This procedure, or mapping, involves finding a common set of variables by which both the training program and the task analysis can be described. (See Fig. 2.) Once a common set of variables is found, it is then possible to determine how well a particular training concept represents critical task information by comparing similarities or differences for each variable.

Implicit in the use of such variables are some distinct methodological assumptions which should be examined. Most training experts agree that two important factors determining the success of a training program are functional and physical fidelity. Physical fidelity means that the training program must capture the essential operations and physical conditions present in the real life situation for which an individual is being trained. In the case of functional fidelity, the critical actions or functions performed by the system user are captured by either exact replication of user actions or by using a psychologically useful analog. Specific rules for generating such an analog are not yet (in the opinion of the authors) sufficiently developed to be useful in CTEA application. The importance of both types of fidelity depends upon a wide variety of factors in the learning situation.

It is obvious that one way to maximize physical and functional fidelity is to do all training on the actual system equipment and in the real environment. Allowing for the fact that personnel must still be taught certain prerequisite skills and knowledges before they can begin to use the actual equipment, this approach is both highly expensive and unrealistic. Consequently, the problem becomes one of choosing some subset of the full range of physical and functional requirements, combining them with groups of devices and methods, and managing the interactions that are generated as a result.

There are at least two approaches for determining subsets. One approach is to select important fidelity related variables by analyzing the current literature on training interactions. One difficulty in assimilating this literature, however, is that the contexts within which studies take place are so varied that it is often difficult to identify causal relations. Good summaries have been produced, e.g., Meister, 1976,[4] however, and are a great aid in pulling together this diversified literature.

A second approach is to use survey information drawn from panels of experts. This type of information is generally more relevant for specific applications, but it often lacks experimental rigor and is difficult to validate. If forced to choose, summary literature seems to present the more immediate

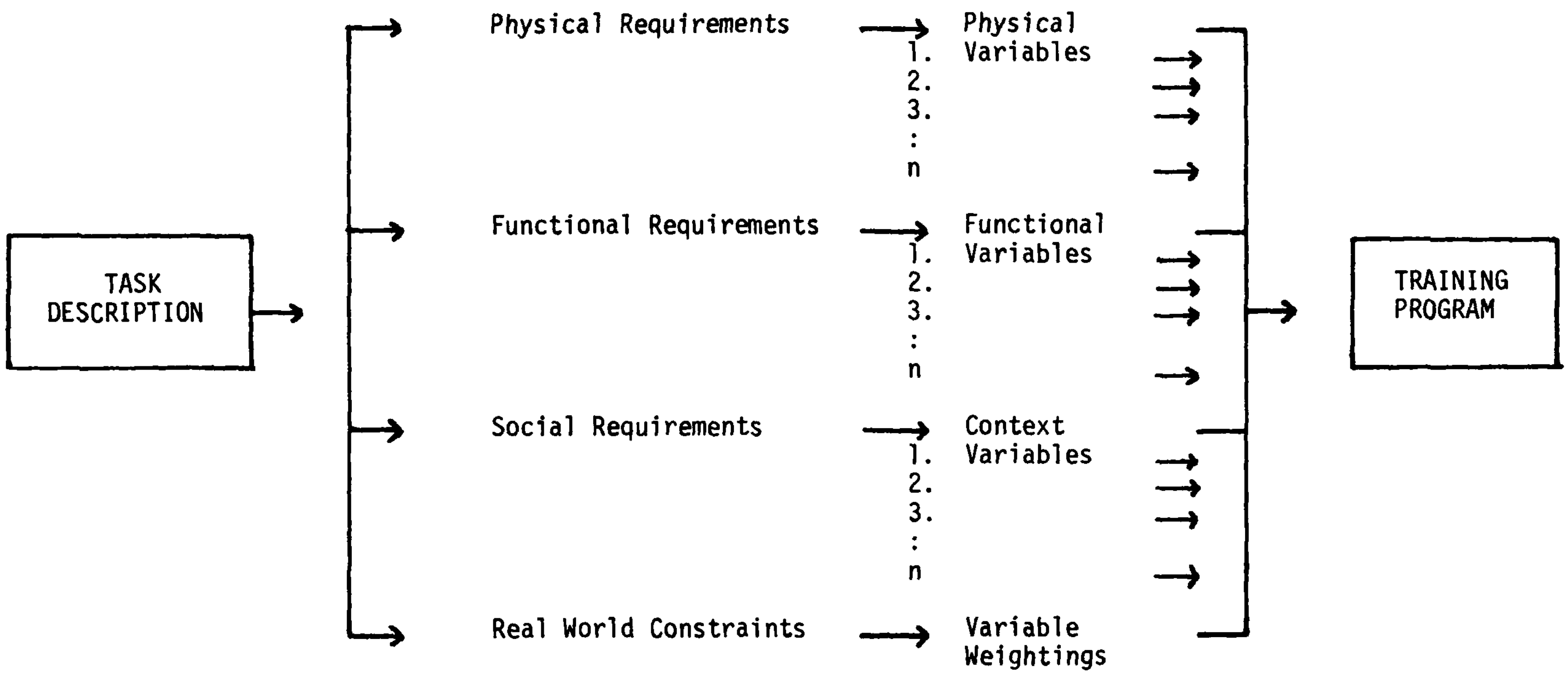


Figure 2. Mapping from task situations to training programs.

data base for preliminary models (Haverland, 1974[5]). The model developed in this paper has utilized summary literature to a large extent.

A.1. A STRING ANALOGY

The model assumes an underlying logic about how the interactions and processes in training programs can be represented. The logic can be visually illustrated by a string of letters, for example: ABCCBFCCBA. Within any string, several things may vary. First, the string is composed of elements, represented here by capital letters. Second, the elements may occupy different positions and occur at different frequencies within the string. Third, the string may vary in length. Finally it may not contain all possible elements that could have been chosen. A training program can be similarly represented.

In a training program there are two basic levels of interest, the program level and the content level. The program level is concerned with the physical equipment and facilities used in the training environment and the social structure or method within which the physical equipment is applied. The content level is concerned with the units of training information which are flowing through the program to a student and are important to a course writer. The interrelationships between information units represent structure, which when specified, create a course text. Both levels of interest are presented below.

Program level	Content level
Equipment & facilities (Media)	Information units (Content)
Social interrelationships (Method)	Information unit interrelationships (Structure)

Both the program level and the content level can be thought of as a string of elements, as described above. For the program level, the elements are the physical media. The interrelationships represented in the ordering of the string are the methods. For the content level, the elements are the units of information to be presented and the interrelationships are the orderings and sequences of information units.

As with the string analogy, elements at the program level may occur at different frequencies, may be selected from a larger pool, may be grouped into strings of different lengths, and may occupy different positions. Elements at the content level may themselves be composed of smaller elements, occur at different frequencies of presentation, and so on.

Other characteristics of a string concern relational properties which the elements have to one another. For example, at the program level, the concern is how the media interrelate. This interrelationship is called the training method. Using the string as an analogy, a convenient breakdown for training progams is made possible. The program breakdown in turn leads to analytical representations which can be paired to training variables. For example, five questions were derived, using the string analogy, to capture the basic differences between existing training methods. First, if a string of training elements does not have a constant sequence over time, who or what controls the sequence? Second, how many times in an instructional string does an element appear? Third, where does each appearance occur? Fourth, if an element influences the sequence of other elements, what degree of influence does it have? For example, if the elements were an instructor, a student teacher, and students, what would be the degree of control of the student teacher relative to the instructor in a given method? Finally, what percentage of the total instructional time is taken up by each of the elements?

These five questions were systematically applied to a number of commonly accepted training "methods" to give them a more precise definition for CTEA usage. Twenty-three such methods are defined in Appendix B-54-76, along with their common narrative descriptions. This procedure not only allows one to describe an existing method but also allows one to produce a number of new training methods based on combinations of answers to the five basic questions.

Until now the string analogy has been used only to consider the program level, but it is equally applicable for the content level. For this level, the elements are units of specific training material, i.e., blocks of course content at any convenient level of description, and their interrelationships, the variables affecting the structure, i.e., the sequencing or patterning of material. At this level of analysis, the problem is one of specific course material and structure, rather than the determination of physical equipment and method. In this way the string can be used as a convenient framework for the division and clarification of processes going on in a training program.

It should be noted that a training program does not operate in a vacuum and that its success or failure is influenced markedly by its environment. Consequently, training program formulation must allow for external impacts, such as managerial limitations, costs, personnel, and so on. In the context of a string, these may be considered modifying factors which change an idealized string of instructional events to a conforming string concerned with practical realities. In this paper, such modifying factors are seen as having a direct impact on the five questions used to define the training methods.

A.2. LINKING THE TASK DATA WITH A TRAINING PROGRAM

In the earlier discussion of the training variables, it was stated that their purpose was to form a common linkage between the physical and functional properties of the task environment and the potential training program. The way in which this linkage is made will now be considered in greater detail.

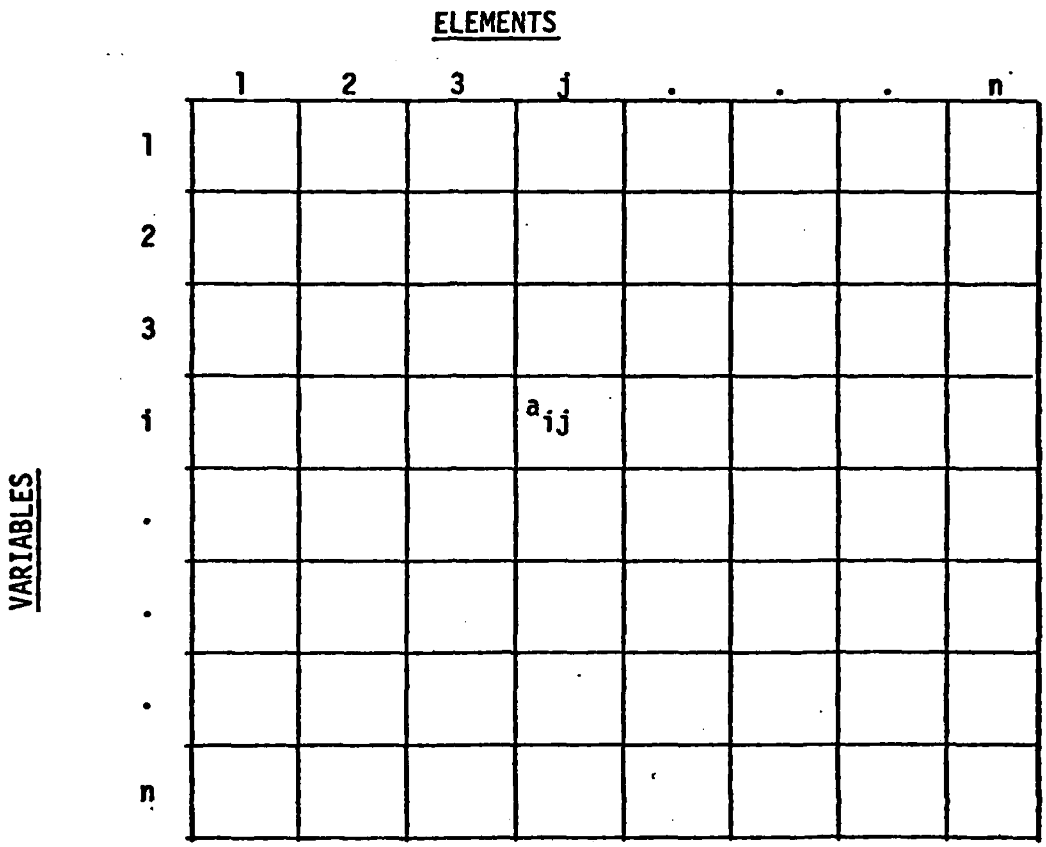
Matrix algebra is a technique that can be used in the application of both the string analogy and the variables. Because of its flexibility, matrix algebra is a powerful tool for characterizing any model. In this particular effort, matrices are at the heart of the method and media selection processes. A sample process will be examined to show how matrix techniques are used.

Recall that the variables are chosen to link the task environment to some aspect of the training environment. Figure 3 shows a sample matrix. Along the X-axis are elements representing either program or content elements. Along the Y-axis are variables representing some subset of training variables corresponding to a particular training program function such as media selection. Each variable along the Y-axis is given a value based on its applicability or nonapplicability to each program or content element along the X-axis. For example, if the element is a "slide projector," and a variable is "visual presentation capability," the variable would be applicable. Using the same logic, each element is then rated in terms of all of the variables for the training program function. The value's applicability or nonapplicability is recorded in the appropriate cell as a nominal, ordinal, or ratio value, depending upon the degree of accuracy with which the assessment can be made. The complete matrix thus represents a description of the set of training elements available to a training manager for that particular function. Such matrices are constructed for each of the training program functions for which training literature indicates such pairings are practical. When the matrices are completed, the training elements will have been described in terms of variables.

A parallel problem, however, is how is task information described in terms of the same variables? A similar procedure can be used. For example, suppose that a task involves reading visual material from a radar scope. If the task also requires a response to some kind of audio information, the variables applicable to the task description will not match the variables applicable to the slide projector in the example above. It might, however, match some other piece of equipment. How this is determined is where a matrix becomes valuable. One difficult way in which a comparison can be performed is to individually examine each variable for each task and compare it to each variable for each training element in a process matrix, such as in Figure 3. Once done, the number of matching variables can be totaled for each training element and the one having the highest score taken as the "best fit" for that task. If the procedure is repeated for all tasks and all variables in each of the training processes and are combined into a single program, a training analyst has a starting point from which to do predictive analysis. Needless to say, this procedure would be extremely time consuming, if done entirely by hand. Fortunately, such a task is made easy through the use of matrix algebra and the procedure is well suited to machine implementation.

A.3. DEVELOPING THE PROCESS MATRICES

Because the objective in the previous section is to choose the device or method having the largest number of similar variables, the matrix operation of premultiplication is an ideal technique. Suppose that the task description is characterized by only three variables. The corresponding matrix cells for these variables are given a value of 1 when they apply. If variables do not apply, they are valued as 0. Similarly, suppose there are only two training elements to be considered in the process, and they are also coded with a 1 or



a_{ij}= A value in a matrix cell representing the degree of applicability or non-applicability of variable i to element j. (a) may be a nominal, ordinal, or ratio value.

Figure 3. Linking training variables to string elements.

0. (In reality, any nominal, ordinal, or ratio value could be used.) To see which element best "fits" the above task, the device matrix (A) is premultiplied by the task variable vector (b), producing a row vector of column sums (c). This vector represents the sum of the number of variables which match both the task description and the device matrix. (See Fig. 4.) Therefore, the second column element in the matrix is viewed as the "best fit" for properties in the task description, i.e., it matches two, the most, task variables. Suppose, however, that there are external factors, such as managerial constraints, affecting the suitability of elements described by matrix (A). If so, this implies that the values in (A) should be weighted. Use of matrix formats makes this a simple operation. For example, if a weight is given to each element that corresponds to its relative desirability, then each column of variables in the matrix must be multiplied by the appropriate weight. Say that the element in column one is four times as suitable as the element in column two. A column multiplication of (A) by a vector of weights, w = (4, 1), produces:

$$\begin{array}{cc} & \underline{\text{Element}} \\ & \begin{array}{cc}\#1 & \#2\end{array} \\ A = & \begin{bmatrix} 4 & 0 \\ 4 & 1 \\ 0 & 1 \end{bmatrix} \end{array}$$

The previous premultiplication by (b) now produces a summed vector c = (4, 2). Element number one would now be the best choice considering these new conditions. The same logic can be used for variables in the task description, the importance of variables in the matrix, or even individual items in the matrix through row multiplication, column multiplication or matrix element replacement, respectively.

Thus the use of matrix algebra presents a powerful analytic tool for applying a wide range of potential interactions and factors affecting the processes for formulation of training programs. A matrix process is for all practical purposes unlimited in terms of the number of variables it can consider, as well as the number of intervening factors that can modify it. In these simple examples, only two or three elements were dealt with. In the computer program for this model, program elements alone number more than 35 for a single process. The logic, however, remains the same in both cases.

B. APPLICATION OF THE METHOD

Up to this point, only the theoretical framework for training program formulation has been considered. It is now necessary to explore the specific ways in which these ideas are implemented. First, generation of the training variables will be considered, since they are central for developing potential training programs.

Step 1 - Recode task B into variable row vector b.

Let: $b = \{0, 1, 1\}$

Step 2 - Choose a device matrix such as in Figure 2, and call it A.

$$\text{Let: } \quad \underline{\text{Variables}} \quad \begin{array}{c|c} & \underline{\text{Elements}} \\ & \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 0 & 1 \end{bmatrix} \end{array} = A$$

Step 3 - Pre-multiply A by b and call the result c.

$$\text{Let: } bA = \{0, 1, 1\} \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 0 & 1 \end{bmatrix} = \{1, 2\} = c$$

Step 4 - Save c for later element choices.

$$\begin{array}{ccc} & \multicolumn{2}{c}{\underline{\text{Element}}} \\ & 1 & 2 \\ c = & \{1, & 2\} \end{array}$$

Figure 4. An example of a device matrix being premultiplied by a task variable vector.

B.1. GENERATING THE TRAINING VARIABLES

The number and kinds of variables affecting training programs that have been considered in the psychological and training literature is extensive. Anyone attempting to systematically reduce these variables into a usable format is struck immediately by the fact that in each experiment and taxonomy variables are confounded in at least two ways. First, there are no standard variable definitions. Second, there is little or no effort made to assure that the variables partition the space of training alternatives in an orthogonal, or at least, non-overlapping fashion. Many variables given different names have within their domain the same variances attributed to other variables. There are, of course, exceptions to this trend, e.g., Finley, et al., 1970.[6] These papers, however, do provide a good starting point for the selection of variables used in this procedure.

To overcome the difficulty noted above, this paper used the following selection strategy. First the summary literature was screened for suitable training variables. The result of this screening was the division of variables into three basic groups: (1) Variables seeming to have effects on training, but with little empirical support; (2) variables having effects on training and having empirical support; and (3) variables have some empirical support, but with very mixed results with regards to training. Due to time constraints, it was not possible to conduct independent experiments on all the variables. Thus, there was no way to assess their consistent impact upon the training processes. Consequently, groups 1 and 3 were excluded from further consideration. It should be noted, however, the matrix framework that is used does permit inclusion of new variables at any time. In addition, the authors felt that until experience is gained with the entire procedure, the inclusion of too many variables could be counterproductive.

Within the group of remaining variables, i.e., group 2, there were still a number of problems to be resolved. The remaining variables were divided into smaller groups based on the functional role they played in the experiments from which they were taken. However, before this could be done, a set of working definitions had to be developed so that variables could be compared across studies. Without working definitions, the variables could be interpreted in any manner and could leave the whole procedure too ambiguous to use. The classification of variables was accomplished using the string analogy discussed on pages 3-4. Each variable was evaluated and revised, and a preliminary set of variables was developed.

In general, the variables were divided into four classes, depending on their domain of influence. These four classes correspond to the program and content level breakdowns shown on page 3. Variables dealing with physical properties of real equipment were classified as media variables. Variables dealing with interrelationships between media items or social structure were placed under the heading of method variables. Variables dealing with the type of information flowing through a training system were placed under the heading of content variables. Finally, variables dealing with the interrelationships between content elements were placed under the heading of structure variables. The following examples may help clarify what role these classes of variables play in the training process.

Example 1

Media variables refer to actual pieces of equipment (or even humans) that can be used to present, accept, or evaluate training information. These are listed in Appendix A. (The media variables were extracted, extensively modified, and combined from TAEG Report No. 16[7] and Meister's Behavioral Foundations of System Development.) For example, a television set is a fairly sophisticated piece of equipment having the capability of presenting color, sound, and movement information. A workbook is also a physical device, but with less capabilities. In another sense, even an instructor can be viewed as a training medium with information handling capabilities.

Example 2

Training method variables (Appendix B) refer to the patterns and sequence of interactions between students and media. For example, team teaching is a pattern of interactions between more than one instructor and more than one student. The variables describing this pattern of interactions are method variables. The generation of the method variables required developing new techniques because no literature was found characterizing methods in a form compatible with the string analogy. Three steps were required initially. First, the five questions discussed earlier on page 4 had to be generated. Second, all narrative descriptions of methods had to be screened and rewritten to reflect the key differences between time. (The narrative descriptions of methods were extracted and modified from W. R. Tracey's Designing Training and Development Systems.[8]) Third, all methods had to be coded in terms of their differences based on the five questions. (See Appendix B.)

Another technique required selecting classes of method variables that would link the task environment to the training environment. This technique consisted of examining the sources of variation in operational environments, selecting variable names to represent that variation, examining sources of variation in the method descriptions, selecting variables to represent that variation, and then matching the two sets of variables. The variables that overlapped, i.e., linked methods and operational environments, were coded in matrix form and adjusted until the space of methods were orthogonally partitioned by variable values. The result was a reduced set of methods which could be shown to be operationally different from one another. This in turn reduced the total set of methods and refined their definitions markedly. Five classes of method variables were developed and they included: (1) The role of the element, (2) the function performed in the role, (3) the stability of the function over time, (4) the effect of physical environment, and (5) the effect of psychological environment. (The coding of these variables is discussed further in Appendix B.)

Example 3

Content variables deal with the particular units of information being taught within the system. These include information such as task type. An example of a content variable is "mathematical manipulation" (Appendix C).

Example 4

Structure variables refer to the way in which content variables are related to one another. They are concerned with such things as repetition, time sequencing, similarity, and spacing (Appendix C).

To generate final sets of all variables, another problem had to be resolved. The problem was the way in which the variables were to be extracted from task analysis descriptions. Since any predictive technique will probably be operating with input information in a variety of forms in early states of weapons systems, the procedure by which information is recoded into variables becomes very important.

One approach is to recognize that all textual information is presented via language, and, consequently, the information carrying elements can be analyzed psycholinguistically. In linguistic circles, breakdown of text seems to follow two tacts. The first, transformational grammar, generally ascribed to Noam Chomsky,[9] corresponds roughly to structure variables. The other dominant tact, case structure grammar, emphasizes the meaning (semantics) of the information and corresponds more directly to the content variables. Typical proponents of this view are Fillmore and Fodor.[10] In general, formal linguistic schemes, although having considerable value for future applications, such as real time language analyzers, (Winograd, 1972)[11] do not have immediate applicability for the processing of task information. In practice, the simple procedure of breaking down sentence structure into noun, verb, and object with adverbial or adjectival modifiers appears quite adequate and has been used with some success in various classification schemes. Identification of critical information is often quite easy for a trained analyst and it is not necessary for him to break task information into linguistic components. However, if such a model were to be entirely automated in the future, a linguistics approach might be of considerable value.

Generally, the analysis of task information for training falls into the following categories. Task verbs are useful for identifying the category of action taking place in the task. When paired to a series of task taxonomies, such as used in the ARI Training Manager Model,[12] considerable insight can be gained into the types of skills and knowledges required for a group of tasks. By pairing the task types to operational training guidelines, it is also possible to generate unique configurations of instructional programs. The ARI Trainvice Model[13] represents one study in this direction. Frequently, nouns in task descriptions apply to pieces of physical equipment or units of information. The appropriate category is clarified by adjectives. Similar clarifications for verbs occur through adverbs and various other modifying phrases. The wide variety of descriptive phrases found in task lists seems natural because of the flexibility of the English language structure. A given object or phrase can have almost any combination or permutation of phrase modifiers. For example, a slide projector can be a random access, high speed, black plastic, carousel projector, or it can be a low speed, sequential, white plastic, individual slide projector. In this example, the modifiers set bounds upon the equipment. But even more, in the case of a task analysis, the modifiers specify conditions for either a functional or physical fidelity match. The most useful insights to be gained from linguistic breakdown concern the way in which the variables are identified to allow maximum transfer of information from the task descriptions into the variable description lists.

After the initial variable screening process mentioned earlier, it soon became apparent that most variables fell cleanly into categories formulated by the string analogy and could be identified by the breakdown of the task information in the simple linguistic model by verbs, nouns, and modifiers.

The final sets of variables are presented in Appendixes A, B, and C. Several things should be noted about these appendixes. For each major heading, such as MEDIA RELATED VARIABLES, pages 41-43, the first class breakdown of variables is in terms of the sensory mode. Depending upon the training function, the trainee's ability to perform in that function depends on two things: (1) The sensory modality through which information is received, and (2) the sensory modality by which he expresses his response to that information. For example, task information can be presented to him through visual, auditory, tactile, external motion, internal motion, olfactory, or taste senses. Similarly, he can respond auditorily, physically, or internally. Each task situation in which the trainee is involved must flow through one of these human information processing channels, and, consequently, it is these channels that form the most logical basis upon which to break down the sets of variables for the model. At the start of each set of variables is a list of sensory mediums by which the training information can be exchanged. A given task or training situation may use one or any combination of these sensory modalities. A list of variables exists for each modality which corresponds functionally to the previously discussed adjectival or adverbial information in the operational environments. For example, six types of "Visual Form" listed under MEDIA RELATED VARIABLES--STIMULI CHARACTERISTICS are all variables for visual sensory information.

Once the organizational structure was chosen, the final sorting of training variables from the literature became straightforward. The string analogy was used to determine the type of process each variable represented, i.e., Methods, Media, Content, or Structure. The linguistic analysis was used to determine whether it was directly related to a sensory modality or whether it was a modifier, limiting the modality and its range of operation. The variables were refined to make better distinctions between nouns (equipment) and modifiers (variables). The result of this refinement was a list of training equipment (Appendix A-36-40), a list of training methods (Appendix B-54-76), and four lists of variables broken down by sensory modalities and modifiers (Appendixes A and B). These lists underwent one last screening to assure consistency and accuracy of definitions.

B.2. IMPLEMENTING THE MODEL

Once the variables were chosen, it was possible to select a specific method to implement the model.

The model begins with preparation of task descriptions. (Refer to Figure 1.) Task information, in whatever form, is broken into the sets of variables by the following procedure. The lists of variables are examined to determine if each is applicable to the task or not. Because of the way in which the variables are presented (see Appendix A-41-43), the analyst performing the initial coding need only scan the lists for sensory modalities and record those that apply. If a sensory modality applies, the analyst records the applicable modifiers for that particular modality. If a sensory modality does not apply, he does not have to scan the modifiers for that modality because they are eliminated from consideration automatically.

The next step, which may be performed either serially or in parallel with variable coding, is the grouping of tasks into functional units for blocked training. (See Figure 1.) (There are many ways this can be accomplished. At present no one procedure has been chosen, although a probable course could be to utilize an existing program developed in the ARI Training Manager Model. The output of this model is a tree diagram of related tasks based on similar personnel, tasks, and equipment functions.) The grouping of tasks is necessary to assure that program generation processes do not combine tasks in totally unrelated fashions. The grouping should be based on logically related functional areas, since each task does not operate in a vacuum, but rather, occurs within some operational context or environment. Recall that it is the operational environment which has considerable implications for the instructional method to be chosen.

When a group of tasks has been chosen by the analyst, the method and the media to be used in the training process must be determined. (See Figure 1.) At a detailed content level of analysis, the particular information which flows through the system, as well as the structure which interrelates that information, must also be derived. For analysts working with relatively gross task data, this level of analysis is not practical. The manner by which content information should be structured and its effect on performance is still highly debatable. Consequently, although the variables for the content level of analysis were developed and are presented in Appendix C, they are not used in the current version of the model. When specific performance predictions do become possible, the matrix format discussed earlier will be capable of easily incorporating this information. Thus, the present paper focuses its attention on those areas most sensitive to cost, namely training equipment and methods, and their subsequent impacts on available resources.

After tasks are grouped, two processes begin. For each task grouping, an appropriate set of training media must be chosen. (See Figure 1.) In addition, operational context within which the media will be utilized must be determined. Just as the trainee interacts with actual equipment within some operational battlefield scenario, he interacts with the training equipment in the scenario of an instructional method.

B.2.a. METHOD SELECTION

The main problem to be overcome in method selection was the identification of suitable variables permitting a linkage between operational and training context. Direct physical fidelity matching used in the construction of simulators or the selection of training equipment was not feasible. Although the answer seemed to lie somewhere in the functional fidelity area, the way in which this linkage could be accomplished was not obvious. Another complicating factor was that teaching methods were not clearly defined in the literature. The problem encountered most often was that both methods and equipment were combined and defined as only method. Thus, many methods were actually very similar, but seemed different, because they used different types of equipment to perform the same functions. The first step, therefore, was to examine the list of methods discussed in the literature and to sort them. Methods having similar patterns of interrelationships were grouped together under the same general methodological headings. In order to quantify the methods, a formal scheme for classifying methods was created.

The string analogy proved useful for accomplishing this task. (See the earlier discussion on method, page 10.) Since many teaching methods center around interpersonal relationships between instructors and students, it was most useful to characterize the variables describing these relationships in human terms, although many interactions going on in training may be between man and machine. Five variable areas appeared to characterize the majority of the differences among methods. These areas considered five characteristics of the training program. They were:

1. Who or what is performing the action or processing?

2. How many times does this action or processing take place in one instructional method sequence?

3. When this performance takes place, in what order is the person or machine in the sequence?

4. What is the percentage of total control which this person exercises over the instructional process taking place at this time?

5. What percentage of the total instructional time is taken up by this activity?

Defining methods in terms of these questions led to the schematic, tabular definitions found in Appendix B-54-76. In all, 23 methods were analyzed and given both narrative and quantifiable definitions.

Once these definitions were generated, it was then possible to establish a mapping between the operational environment and the training environment for a given group of tasks. As anticipated earlier, a method's benefits served as a logical link between the actual operational environment and training method. Each method generally has ascribed to it certain idealized characteristics. These characteristics are the reason for choosing particular configurations over others. (See Appendix B.) Because the trainee is the focus, one logical way to link the functional variables and training methods is:

Step One: Identify the idealized characteristics which expert opinion attributes to each method.

Step Two: Based on the characteristics which relate the trainee to his functional context in the classroom, identify common variables between the functional classroom description and the operational context.

Step Three: Retain those variables common to both situations and code them in the process matrix.

The result of this process can be seen in Appendix B-79. Along the Y-axis are five variables that were found to overlap both situations. They are: (1) The role of the performing trainee within the operational context of the system, (2) the particular function performed by the trainee within that role, (3) the stability of that function over time, (4) the significance of the physical environment upon performance of the task, and (5) the significance of the psychological environment upon performance of the task. Each of these classes of variables could theoretically have an indefinite number of levels. The number of levels chosen for this paper was somewhat arbitrary; however, the number selected appeared to be adequate for classifying the methods. Role was divided into three levels describing functions performed by the trainee in his actual duties and each class was broken down as follows: (1) supervisory, where one or more persons are involved; (2) team performance, where the trainee has equal roles with other individuals or equipment; and (3) individual performance, where the trainee performs a given task on an individual basis. The function was broken into four levels corresponding to the type of operation being performed in the role. Many more levels could have been used, for example, Willis and Peterson's[14] task taxonomy with 12 levels could have been chosen equally as well. It was not clear, however, how the advantages attributed to specific methods of instruction could be divided much finer, and, consequently, only mental, physical, perceptual, and communicative functions were considered at present. Stability, which reflects how often the function performed in the operational context changed, was divided into two levels, high and low, due to lack of precise causal relations. Physical context, referring to the effects which physical characteristics such as cramped space or chemical warfare environments might have on performance, was also broken into two levels. Psychological context includes mental influences, such as peer pressure, which could affect job performance in operational situations. Other examples are time pressure and motivation. Psychological context was also broken into two levels, high and low. Should other variables prove useful in the future, the matrix structure of this procedure will permit their rapid inclusion. The entire process has been designed to accommodate such modifications and allow for new training research and policy changes.

Each of the 23 methods mentioned earlier was coded in terms of its ability to manipulate each of the five variables for a trainee. The matrix is found in Appendix B-79, with each column corresponding to one of the methods and each row to one of the levels of the functional context variables. If a given method includes more than one level of a variable, it is coded in each row where it applies. As can be seen from Appendix B-79, each method differs somewhat in terms of which functional context variable it manipulates. Thus, it is possible to match the fielded operational context within which the trainee <u>will</u> work with the variables describing the method which can produce similar training environments. It is recognized that for various reasons a particular school may not desire to train an individual in a manner that corresponds directly to his or her field environment. In such a case, adjustments can be made to the matrix to represent differences by changing their relative weights as shown earlier. One advantage of the current approach is that training is oriented toward battlefield training, and any change would require explicit changes in matrix weights, thus highlighting cases where battlefield performance was not the final goal.

As more is learned about the relative advantages or disadvantages of each training method from actual performance data, the matrix can be selectively weighted to produce a better and better fit.

B.2.b. MEDIA SELECTION

The selection of training media follows much the same logic as method selection, except that the media selection process involves three subprocesses corresponding to different information flows taking place in a training program. These flows are stimulus presentation, response acceptance, and feedback evaluation. Each complete instructional sequence includes one or all of these components. The three subprocesses may be performed by a single piece of equipment, a single individual, or a combination of both. For example, stimulus information may be presented by a radar screen, the response of the operator to that stimulus may be an audio reply through a radio net, and the evaluation of the correctness of the response may be a verbal one made by a commanding officer standing nearby. On the other hand, the entire sequence may take place entirely between the operator and a computer controlled threat evaluation system contained within the weapon itself.

This kind of flexibility points out a problem with matrix or network selection systems which have only a single media selection process. Because one matrix then includes all the selection subprocesses, it is inherently biased in favor of a single device having the largest number of capabilities, simply because that device is most flexible. The result is that real equipment or simulators are almost always chosen, even though several smaller, but less expensive components can be fitted to duplicate information flows performed in the same task. In this paper each of the three subprocesses has its own set of relevant variables. The complete set of variables for each subprocess is found in Appendix A. Even though each subprocess has its own special characteristics, there is variable overlap. The set of variables for media corresponds directly to the sensory characteristics of the training situations, i.e., stimulus, response, or feedback. The process matches the elements having physical and functional fidelity in the operational equipment with the elements of the training environment in contrast to method selection, where the determination of a method was more directly related to social interactions between students and the persons or equipment performing the media functions.

Media selection is made by comparing coded task data with selection matrices in the same manner as the earlier matrix example. These selection matrices are shown in Appendix A-44, 45, 48, and 51. At this time, there is not enough data to put specific weighting values in the matrix, so 1 and 0 are used to represent applicability or nonapplicability, respectively.

B.2.c. CONTENT AND STRUCTURE SELECTION

The two sets of processes which have not been considered up to this point, involve those variables relating to the information flowing through the training equipment and their configuration. These were called content and structure variables. The entire area dealing with individual differences and their effects and interactions with course material is hotly contested. For a predictive methodology, it would appear to be premature to attempt anything more than general statements in this area. In the present model, several procedures were considered to handle these remaining areas. The procedure that seemed most applicable for future use consisted of using a verb dictionary to select information content presented in each task set. Each entry in the verb dictionary is paired to a categorical heading or task type. Associated with each task type were lists of guidelines or flowcharts which served as a coursewriter's aid for generating courseware material. Currently, ARI has an ongoing research effort, Training Managers Model, handling the problem in this manner. Another effort aimed at the prediction of training device effectiveness, the Trainvice Model, also contains guidelines which could be paired to the same categories. It was felt that these efforts are not sufficiently developed to be useful for early training prediction although they have important applications at other levels of training development. Consequently, this paper strives only to predict the grosser elements of the training program related to costing media and method choices. Because of this limitation, predicting overall field effectiveness is limited.

B.2.d. EFFECTIVENESS PREDICTION

Effectiveness prediction is probably the most difficult problem to solve in CTEA. An important contributor to this difficulty is ambiguity about the range of effects which should be considered. Specifically, how extensively should effectiveness be defined for CTEA in contrast with COEA or battlefield simulation? Although there is no doubt that training directly influences field performance, the linkage between training programs and terminal battlefield performance is much more tenuous. For example, studying 10 hours using a carousel projector instead of 12 hours using a textbook may have a later impact on battlefield performance, however, the chain of causal events is contaminated by so many other factors that it seems futile to attempt predictive links at such a level. What can be done is to break the causal chain into a series of larger, more controllable, sequences of events, and attempt to predict them. Later, that information may be used in combination with other factors as the basis for predicting overall battlefield performance. The implication of this for CTEA is that a measure of effectiveness must at present be taken from the battlefield and focused on the school where the degree of control is the greatest. The measure chosen in this paper is even more restricted. What can be controlled is the efficiency with which a projected training program is developed. Theoretically, there are least five sources of information in this model from which an effectiveness metric can be fashioned. All four process selection matrices and the variables themselves could be used as predictors using a form of regression equation. Many other pieces of information, also possible, are not presently being considered, such as managerial constraints, personnel characteristics, teacher characteristics and a host of aptitude by treatment interaction variables.[15] A practical choice for the present is to record alternative costs produced in the generation of a projected program. Individual decision costs are then combined to determine the overall loss for a predicted, but constrained, training program versus an "ideal" program with no constraints. Although such a metric supplies no information about the absolute scalar properties of a number so generated, it does provide a relative standard of comparison for several training programs generated using the same method. This has potential advantages not only for the comparison of alternative programs within a given weapon system, but also between systems.

In this paper the metric is referred to as an efficiency ratio. It represents a value which is composed of the total matrix "fit" of a projected training program with real world constraints, divided by the fit of an idealized program which is subject to no constraints. The value is generated in the following manner. First, the selection matrix scores for each media matrix are recorded. (See vector c in the example in Figure 2.) Repeated over all tasks this produces three new matrices of c vectors where the rows now correspond to tasks and the columns correspond to the degree of fit which that task had with each of the potential training media. If the largest sum in each of these rows is chosen, a large number of different equipment choices would be produced spread over all the tasks which are being considered. Thus, for a sample group of six tasks there might be six different media choices for each of the three media functions or a total of 18 different devices. If cost were no object, and there were no resource or time constraints, the ideal choice of media would be all 18 devices. The total of the equipment fit scores for those 18 pieces then represents an ideal choice without constraints. This, of course, is not realistic, since there are always constraints that enter into any decision. As constraints are applied, the viability of a particular piece of equipment for a particular task may change, just as it did in Figure 2. For example, even though it may not be optimal equipment, the training manager may have on hand a particular training device and want to include that equipment in the program, rather than buy a newer, more expensive one. Perhaps the piece of equipment permits combining several tasks rather than individually training each. In the above discussion, this corresponds to choosing one of the other sums in a column representing the particular piece of equipment the manager desires to use. If he were now to do this for all six tasks, i.e., force the choice of the same piece of equipment, the sum of the numbers across tasks would be much lower. Thus, the efficiency of that particular decision would be lower than the ideal case, as would all other potential combinations. If this value is then divided by the ideal first value, what would be produced is a percent ratio of actual to ideal, or in the terminology used above, an efficiency ratio. This is the approach used in this model. (See Figure 5.)

In actuality this procedure becomes much more complicated, when many tasks, media functions, and media types are considered. The actual program is somewhat analogous to the statistical technique of hierarchical grouping analysis, where the ideal program is a starting point, and the number of potential media is gradually reduced in a step-wise function while keeping track of the tasks which are subsummed under each function and media type. As the number of media is reduced, a plot is made of the efficiency ratios for each combination. The result illustrated in Figure 5 is a graphic aid to allow an analyst to identify the point at which further trade offs in equipment begin to have significant effects on the training fidelity of the system. This point is represented by a sudden drop in the ratio value. This will become more obvious in the example given later.

B.2.e. THE COSTING PROCEDURE

A final problem consists of the costing procedure by which the output of the method and media estimations are analyzed. This model uses a costing program originally developed by the Navy for this purpose.[7] Equipment and method variables are costed in terms of a set of 37 variables specifically related to a cost accounting procedure. These components are then put into a computer program which calculates the costed output. This cost model is currently in use by the U.S. Army Air Defense School for overall training estimates in the ROLAND system and is being considered for Army-wide application. A modified version of this program is proving helpful in aiding decision makers after a training program has been developed. An example of a preliminary application

Step 1 - Group all (c) vectors (see Figure 4) into 3 matrices corresponding to stimulus, response, and feedback functions for media selection.

	Stimulus			Response			Feedback		
Task 1	C_{11}	$C_{12}\cdot$	$\cdot C_{1n}$	C_{11}	$C_{12}\cdot$	$\cdot C_{1n}$	C_{11}	$C_{12}\cdot$	$\cdot\cdot C_{1n}$
Task 2									
.									
.									
Task n	C_{n1}	$C_{n2}\cdot$	$\cdot C_{nn}$	C_{n1}	C_{n2}	$\cdot\cdot C_{nn}$	C_{n1}	$C_{n2}\cdot$	$\cdot\cdot C_{nn}$

Step 2 - For each task choose the largest value of C_{ij}, i.e., L_{ij} and add over all tasks. This produces 3 sums, one for each matrix: $S_{stimulus}$, $S_{response}$, and $S_{feedback}$.

$$S_{stimulus} = L_{Task\ 1} + L_{Task\ 2} + \ldots L_{Task\ n}$$

$$S_{response} = L_{Task\ 1} + L_{Task\ 2} + \ldots L_{Task\ n}$$

$$S_{feedback} = L_{Task\ 1} + L_{Task\ 2} + \ldots L_{Task\ n}$$

Step 3 - Add the three S values together for a measure of the overall fit of the C_{ij} chosen for all tasks and all functions.

$$\text{Overall Measure} = S_{stimulus} + S_{response} + S_{feedback}$$

Step 4 - Record the overall measure. Repeat Steps 1-3, after removing the media in each stimulus, response, and feedback matrix (Step 1) having the lowest column sum across all tasks. Record this new overall measure, and repeat until all media have been considered.

Figure 5. The generation of a single efficiency ratio and plot of possible ratios.

Step 5 - Plot the ratios of the overall measure values, using the first value as the denominator for all the remaining values.

$$\text{Ratio 1} = \frac{\text{First Overall Measure}}{\text{First Overall Measure}} = 1$$

$$\text{Ratio 2} = \frac{\text{Second Overall Measure}}{\text{First Overall Measure}} = \text{Some Value} < 1$$

.

.

.

$$\text{Ratio n} = \frac{\text{Last Possible Overall Measure}}{\text{First Overall Measure}} = \text{Some Value} \ll 1$$

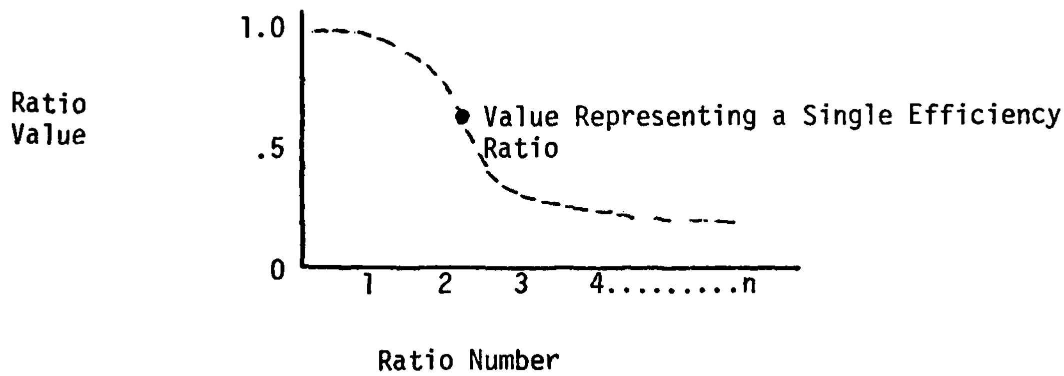


Figure 5 (Continued)

of the Navy program is available as part of an ARI Technical Memorandum[16] written in late 1975 as part of a preliminary feasibility study of matrix selection concept and costing logic in COEA.

C. AN EXAMPLE

In order to pull together the prediction techniques, a simplified example is given. Figure 6 should be continually referenced for a clearer picture of the interactions among components. To make the example as simple as possible only a single task is considered and traced through the model. This will, however, artificially constrain certain areas. These will be elaborated as they are reached. The following is a sample task:

> Assume the trainee is to be used in an Air Defense System consisting of an interactive radar scope connected to a computer and a print out device for typed material. He is to detect malfunctions in the system resulting in unpredictable error messages appearing on the screen. Upon detection of an error he is to use the keyboard printer to make another display scope operational and is to verify the result of the change on the keyboard printer output produced by the computer.

The task description is first compared to the variables listed under MEDIA RELATED VARIABLES--STIMULUS CHARACTERISTICS, Appendix A-41-43. Note that comparison of the task and variable list numbers 1-7, shows only variable 1 (visual symbolic) to be applicable. Because sensory modalities numbers 2-7 do not apply, they can be eliminated along with variables 25-30 which apply to audio stimuli only. Variables 8-24 and 31-39 must now be examined for their applicability to the task description. If a variable is shown to be applicable it is scored with a 1, and if it is shown to be non-applicable, it is scored with a 0. These evaluations are kept on separate task coding sheets, like the one found on page 39.

The example involves observation of a visual display. Normally, the "Visual Forms," variables 8-13, which can be presented on displays, include alphanumeric, symbolic, and graphic information (8, 9, and 10), but do not include other forms, such as pictorial, solid object, or environmental (11, 12, and 13). Variables 8, 9, and 10 would each be coded as 1 on the coding sheet, while variables 11, 12, and 13 would be coded as 0. A similar procedure is used for all other relevant variables. For instance, a message found on a display may change at any time, and is therefore not static (31). Messages presented on the displays are also quite random in time (33), rather than ordered (32). Therefore, variables 31 and 32 would be scored with a 0 and 33 would be scored with a 1. Once the entire list of applicable variables has been scored on the coding sheet in this manner, the task will have been described for the stimulus situation which initiates the operator actions. (See the first row of the Sample Coding Sheet for the applicable variables for this sample task on page 39. This entire row of variables corresponds to the row vector for the stimulus situation.)

The next step is to generate the row vector corresponding to the MEDIA RELATED VARIABLES--RESPONSE CHARACTERISTICS, Appendix A-46-47. Only the physical properties of the equipment which receive the operator's response to the stimulus are considered. In this example, note that the operator's response is

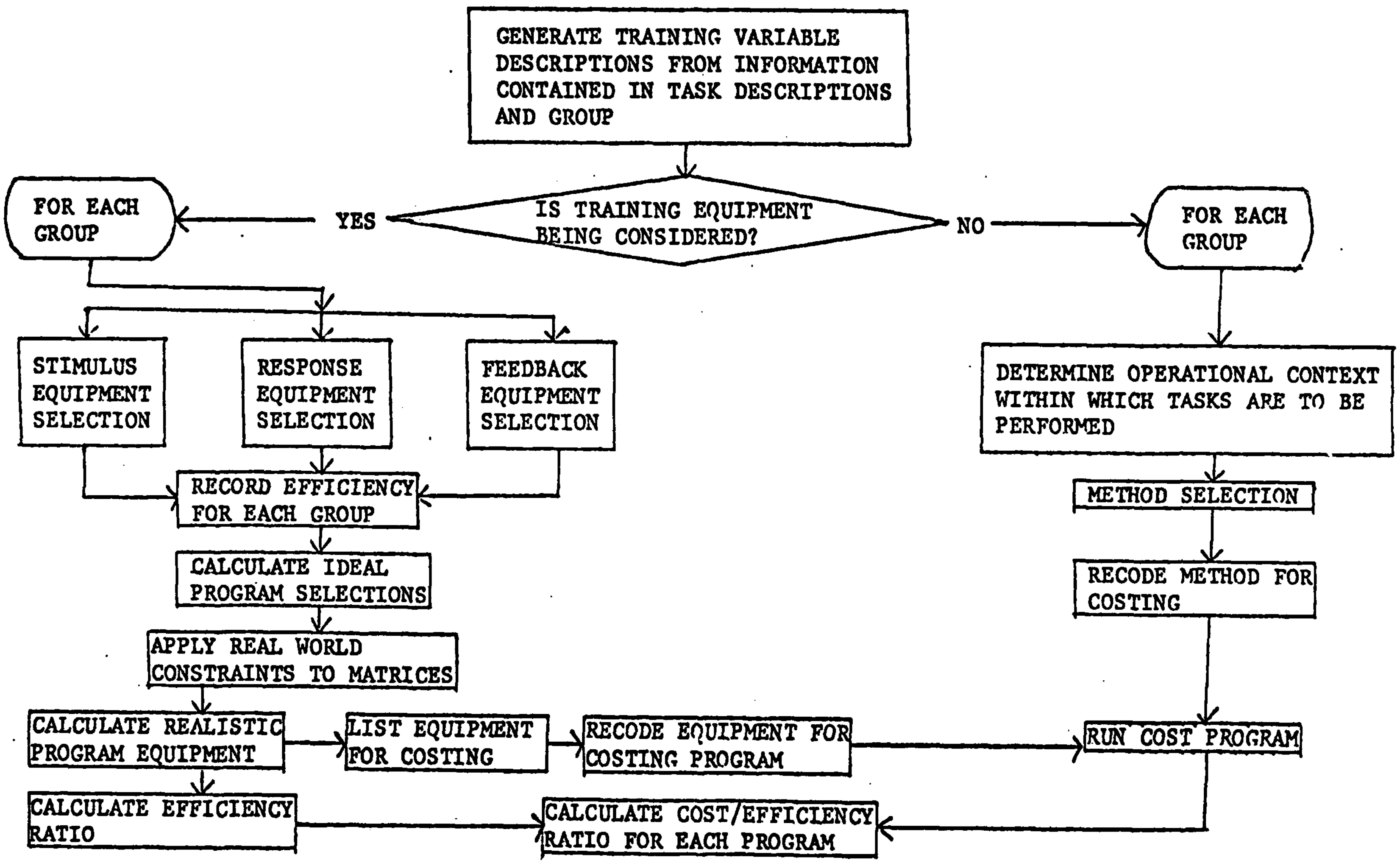


Figure 6. The flow of training program formulation.

SAMPLE
CODING SHEET

VARIABLE NUMBERS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0
2	0	0	1	0	0	1	0	0	1	0	0	1	1	0	1	0																							
3	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	1	0																						
4	0	0	1	1	1	1	0	0	1	1	0	1	0																										

1 = Applicable Variable   0 = Non-Applicable Variable

Selection Matrix Type:
1 - Media Selection - Stimulus Variables
2 - Media Selection - Response Variables
3 - Media Selection - Feedback Variables
4 - Method Selection - Functional Context Variables

39

Sample coding sheet.

overt, i.e., visible, and involves the manipulation of buttons on a keyboard printer. Thus, variables 1, 2, 4, and 5 are coded as a 0, and 3 is coded as a 1 on the coding sheet. Likewise, the responses are not found to require major physical movements and are coded as weak intensity responses (6). Since the trainee is manipulating equipment, the responses he produces will be dynamic-ordered (9) and the equipment must be capable of accepting such a response. Similarly, the response rate would probably be fast (12), the number of response channels, limited (13), and the response distribution, individual (15). (See the second row of the Sample Coding Sheet for the applicable variables for this sample task. This entire row of variables corresponds to the row vector for the response situation.)

The task is now coded in the same manner for feedback variables, Appendix A-49-50. In this example, the medium of information is written form (3). The source of feedback is intrinsic (10), the type of feedback is both response consequences (14) and system status (15), and the feedback distribution is again individual (16). (See the third row of the Sample Coding Sheet, page 39, for the applicable variables for this example. This entire row of variables corresponds to the row vector for the feedback situation.)

After the task information has been recoded into variables directly related to media choice, another evaluation is required. A group of tasks would now be evaluated in terms of operational context variables for method selection. Because this example only deals with a sirgle task, this coding is artificial, since normally a method would not be chosen for a single task situation, but rather for the overall environment within which a cluster of related tasks would be performed. The method variables are found in Appendix B-77. (Note: In Appendix C-82-86 there is another set of variables broken down by stimulus, response, and feedback functions. These variables were drawn from the summary literature, but are not used in the method selection matrix. A mapping did not seem possible between the operational context and these variables at this time. However, they are included in Appendix C as a resource, having undergone the same sorting and reduction processes as the other variables. These variables might be useful in the future generation of a predictive regression equation for training methods.)

Coding the method process requires the same mechanical procedure used to code the media subprocesses. For this sample task, the role performed by the operator in the real environment is individual performance (3). The functions performed in the role are primarily mental, in terms of analyzing printouts (4); physical, in terms of selecting display console options (5); and perceptual, in observing the displays (6). The function is basically stable (9), since it does not change often. The impact of the physical context (10) and psychological context (12) is low. (See the fourth row of the Sample Coding Sheet for the applicable variables for this sample task. This entire row of variables corresponds to the row vector for the functional context variables for method.)

Because the model does not presently use content or structure information no other codings are necessary for this sample task. (Content and structure variables are listed in Appendix C-87-98 only as a future research resource.)

Selection processes can now be performed. First, the media-stimulus selection matrix, shown in Sample Figure 7, is premultiplied by the stimulus row vector. The result of this multiplication is the vector of sums (a), which reflects how well each device fits the conditions described by the task vector. Vector (a) can be found on the bottom row of the sample figure. The pieces of equipment showing the "best fit" are carrel (19), dial access information retrieval system--audio/visual (20), and computer (32). Because only a single task has been used in this example, more than one piece of equipment shows the same value. However, if more tasks had been used, the selection process would have narrowed down the number of "best fit" pieces of equipment. If there are a number of pieces of equipment that have the same value, the equipment that costs the least would be the one selected. Complete descriptions of the three devices selected are found in Appendix A-36-40.

In a similar fashion, the response matrix, found in Sample Figure 8, is premultiplied by the response row vector. The result of this multiplication is the vector of sums (b). Vector (b) can be found on the bottom row of the sample figure. The largest value in the vector is 6, which corresponds to carrels (19), demonstrators (33), mock-up and panel (34), and operational equipment (35). The description for each of these devices can be found in Appendix A-36-40.

Finally, the feedback vector is multiplied. Its vector of sums (c) can be found on the bottom row of Sample Figure 9. The "best fit" media are computer (32) and operational equipment (35).

Now the method can be selected. Using the operational context (method) row vector, a vector of sums (d) is produced from premultiplication of the method matrix. (See Sample Figure 10.) The method selected is tutoring (13). Its description is given in Appendix B-66, both in the detailed string analogy and narrative formats.

For this example, the complete package would consist of a carrel for a stimulus presentation device, the carrel for a response acceptance device, and a computer for a feedback evaluation device. The "best fit" method would be tutoring. If "instructor" had been included as a type of media in the selection matrices for media, the probability that an instructor would have been chosen over a computer for feedback evaluation is high, since he probably costs less and is much more flexible. In addition, an instructor would fit well with the tutorial method selected.

This example has been made artificially simple and, therefore, is limited. Only one task at a time is being considered in the selections of stimulus, response, and feedback equipment and method. Because only a single task is used, graphic analytic aids for the manager cannot be shown. If several tasks had been used, there would have been three vectors of sums for each media subprocess. Each one would have been grouped in a matrix and have been subjected to the procedure that generates the efficiency ratios. When a large number of unrelated tasks is considered, a number of equipment choices may be generated, but when a small number of highly related tasks is considered, the result is often a single piece of equipment.

SAMPLE FIGURE (7) MEDIA SELECTION MATRIX

STIMULI VARIABLES	TRAINING EQUIPMENT & MATERIALS																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1		
3																																	1	1	1			1
4																																			1			1
5																			1														1	1	1			1
6																																			1			1
7																																			1			1
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11		1		1	1		1		1		1	1							1	1	1		1	1	1	1	1	1	1	1	1				1		1	
12																			1														1	1	1		1	
13																																	1		1		1	
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15																																1	1	1	1		1	
16																			1	1			1			1	1	1	1	1	1				1		1	
17												1							1	1			1	1	1	1					1		1		1		1	
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19		1		1	1		1		1			1							1	1	1		1	1	1	1	1	1	1	1	1			1	1		1	
20	1	1		1	1		1		1		1	1							1	1	1		1	1	1	1	1	1	1	1	1		1	1	1		1	
21				1															1														1	1	1		1	
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23									1			1							1	1	1		1	1	1	1	1	1	1	1	1				1		1	

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Figure 7. Media selection matrix.

SAMPLE FIGURE (7) MEDIA SELECTION MATRIX (Con't)

STIMULI VARIABLES CONT'D 43	TRAINING EQUIPMENT & MATERIALS																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
24	1	1	1	1	1	1	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	[illegible]	1	[illegible]
25																																		1	1	1		
26														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1		
27													1	1	1	1	1		1	1	1	1	1	1				1	1	1	1				1	1		
28													1	1	1				1		1	1		1											1	1		
29													1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1	1				1	1		
30													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		
31	1	1	1	1	1	1	1	1	1	1	1	1							1	1	V	V		V	V							V		1	1	1	1	1
32		1							1			1	1	1	1	1	1		1	1	1	A	1	1	1	1		1	1	1	1	V	V	V	1	1	1	1
33	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	A	A	1	A	A	1	1	1	1	1	1	V	[illegible]	V	1	1	1	1
34		1							1			1	1	1	1	1	1	1	1	1	1	A	1	1	1	1		1	1	1	1	1			1	1	1	1
35	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1	1	1	A	A	1	A	[illegible]	[illegible]	[illegible]	1	1	1	1	1	[illegible]	[illegible]	1	1	1	1
36	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37																		1															1		1	1	1	1
38	1	1	1	1	1	1	1	1	[illegible]	1	[illegible]	[illegible]	1	1	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1	1	1	1	1	1	1	1	1
39		1		1					1		1	1	1	1		1		1	1		1		1	1				1	1	1	1	1	1	1	1	1	1	1
(a)	10	11	10	10	10	10	10	10	9	10	9	9	3	4	4	4	4	3	12	12	9	10	10	9	10	10	6	11	11	11	11	12	5	7	11	4	8	4

A = Audio Only V = Visual Only

Figure 7 (Continued)

SAMPLE FIGURE (8) MEDIA SELECTION MATRIX

RESPONSE VARIABLES 45	TRAINING EQUIPMENT & MATERIALS																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1														1	1		1	1	1								1	1	1	1	1	1			1			
2						1		1											1						1	1						1			1			
3		1																	1														1	1	1			
4																																1	1	1	1			
5		1		1		1		1						1	1		1	1	1									1		1	1	1	1	1	1			
6														1	1		1	1	1								1	A	1	A	A		1	1	1			
7														1	1		1	1	A								1	A	1	A	A	A	1	1	1			
8						1		1						1	1		1	1	1						1	1	1	1	1	1	1	AW	1	1	1			
9		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	A-	1	1	1			
10		1				1		1						1	1		1	1	1								1	1	1	1	1	A-			1			
11		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
12		1		1		1		1						1	1		1	1	1							1	1	1	1	1	1	1	1	1	1			
13						1											1	1	1						1	1	1	1	1	1	1	1	1	1	1			
14																																	1		1			
15		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
16														1				1										1	1	1	1	1	1	1	1			
(b)	0	5	0	4	0	4	0	4	0	0	0	0	0	5	5	0	5	5	6	0	0	0	0	0	4	4	5	4	5	4	4	4	6	6	6	0	0	0

A = Audio Only AW = Audio and Written Only A- = All but Audio

Figure 8. Media selection matrix.

SAMPLE FIGURE (9) MEDIA SELECTION MATRIX

FEEDBACK VARIABLES 46	TRAINING EQUIPMENT & MATERIALS																																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1		1				1						1							1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
2													1	1	1				1		1	1	1	1	1	1		1	1	1	1			1	1			
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
4																																			1			
5															1		1	1									1	1		1					1			
6																																			1			
7																			1														1	1	1			
8																																			1			
9																																			1			
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	1		1	1	1		1		1	1						1				1																1	1	1
12		1				1		1			1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1			1			
13																	1	1									1	1		1		1	1	1	1			
14																	1	1									1	1		1		1	1	1	1			
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17		1									1	1	1	1			1	1	1		1		1	1				1	1	1	1	1	1	1	1			
(c)	0	3	0	0	0	3	0	4	0	0	2	2	2	2	2	0	2	4	3	0	1	2	1	1	3	2	3	4	2	4	2	5	4	3	5	0	0	0

Figure 9. Media selection matrix.

SAMPLE
FIGURE (10)
METHOD SELECTION MATRIX

	Functional Context Variables \ METHOD	1 Lecture Standard	2 Lecture-Team Teach	3 Conference - Directed Discuss	4 Conference - Seminar	5 Demonstration	6 Performance-Man. Ind. Practice	7 Performance-Man. Student Tutor	8 Performance-Man. Group Practice	9 Performance-Man. Group Contr. Prac.	10 Programmed Instruction	11 Study Assignment Individual Study	12 Study Assignment Supervised Study	13 Tutoring	14 Case Study	15 Incident Method	16 Role Playing	17 Sensitivity Training	18 Games	19 In-Basket Exercise	20 Brainstorming	21 Committees	22 Field Trips	23 Panels
Role of Element	Supervisory 1																X	X	X	X				
	Team Performance 2			X	X			X	X	X					X	X			X			X		
	Individual Performance 3	X	X	[illegible]	[illegible]	X	X	[illegible]	[illegible]	[illegible]	X	X	X	X	[illegible]	X	[illegible]	X	[illegible]	X	X	[illegible]	X	X
Function Performed in Role	Mental 4	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	[illegible]	[illegible]	X	X	X	X	[illegible]	[illegible]	X
	Physical 5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	X	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Conceptual 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	[illegible]	X	[illegible]	[illegible]	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	[illegible]
	Communicative 7			X				X	X	X				X	X	X	X	X	X			X		X
Stability of Function	Unstable 8		X		X								X	X	X	X	X	X	X	X	X			
	Stable 9	X	[illegible]	X	X	X	X	X	X	X	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	X	X
Physical Context	Low Impact 10	X	X	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	X	X	X	X	X	X	X	X	X	X	X	[illegible]	X
	High Impact 11					X	X	X	X	X				X									X	
Psychological Context	Low Impact 12	X	X	[illegible]	[illegible]	X	[illegible]	[illegible]	[illegible]	X	[illegible]	[illegible]	X	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	X	[illegible]	X
	High Impact 13			X	X		X	X	X		X	X		X	X	X	X	X	X	X	X		X	
	(d)	5	4	3	2	4	3	2	4	3	5	4	4	6	2	3	2	3	2	3	3	4	3	5

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Figure 10. Method selection matrix.

Cost information would also be required for the example. First, a variable sheet, like that shown in Appendix D, would be filled out for each piece of equipment. This procedure is included because of its implications for including the remaining variables, such as number of instructors, floor space, student turnover, etc. This data is punched out and submitted for computer analysis. The output of this analysis, combined with the efficiency ratio, constitutes part of the input for a CTEA of a given weapon system.

In its current state, the model is now undergoing its first stages of testing. The costing portion, as mentioned earlier, is being actively used by the Army Air Defense School at this time. The selection portion has been coded into a computer program suitable for running on an IBM 360-65 operating system. It is currently being used by the TRADOC System Analysis Activity (TRASANA) Training Effectiveness Analysis branch for initial estimation in a variety of CTEA studies. Greater model specification should result as experience is gained. It is anticipated that weighting vectors for the processes resulting from managerial variables, gross cost factors, and personnel characteristics will be included and continually refined.

Many problems still remain in the training program formulation area. It is hoped that the present approach may provide a useful starting point for the CTEA requirements dealing with the early prediction of training programs and help with the many trade-off decisions that must be made prior to full scale development.

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APPENDIX A

MEDIA

TRAINING EQUIPMENT & MATERIALS

Visual Only Systems

1. Case Study Folders - Folders with illustrative studies showing cause and effect information, may include pictures, graphs, maps, charts, etc.

2. Flash Cards - A set or deck of cards designed to present information to a group or individual student.

3. Printed Materials - Handouts - Handouts are a class of printed materials issued to a student for his use and retention to augment regular instructional materials. They are usually instructor prepared, machine copied materials of one or two pages highlighting specific topics or updating existing materials.

4. Printed Materials - Performance Aids - Performance aids are a class of printed materials that display data to aid in job performance or to identify facts or background information. They include conversion tables, data charts, schematic diagrams, equipment test tolerance matrices, checklist routines, maps, and the like.

5. Printed Materials - Reference Books - Reference books are a class of printed materials used to identify certain facts or for background information such as dictionaries, encyclopedias, technical publications, guides or manuals.

6. Printed Materials - Workbooks and Exercises - A class of printed materials used to augment or replace instructional texts by providing a mix of text information and/or practice exercises and quizzes.

7. Printed Materials - Textbooks - Textbooks are a class of printed material dealing with a subject of study and used as a principal source of organized information.

8. Programmed Text - A printed text containing frames of information, either in the form of questions requiring the trainee to construct simple written responses, multiple choice questions, etc. The material is carefully sequenced, tested, and revised to ensure that a specific student population will achieve stated behavioral objectives with a predetermined level of success.

9. Filmstrip Projection System - A single frame projector or attachment thereto that will accept a filmstrip format and project the film images upon a viewing screen.

10. Microform - Microimagery, such as microfilm, used as a medium of instruction.

11. Overhead Projection System - A system consisting of a horizontal stage projector designed to use a vertical throw for focusing an enlarged transparency image upon a projection screen.

12. Slide Projector System - 2" x 2" - A class of single frame picture projectors that will accept a standard 2" x 2" slide and project the contained image upon a viewing screen.

Audio Only Systems

13. Audio Disc System - An audio system that uses a record player and sound recorded on a disc (record).

14. Audio Tape System - An audio system that uses a tape recorder/reproducer to record sound on magnetic tape.

15. Language Laboratory - Audio - An audio presentational device that distributes audio information via a control console to student stations equipped with headsets, and may have a microphone for console/instructor-student intercommunication and a tape recorder. Student may interact with taped instructional material, rewind and play back or store responses. Student responses may be monitored or recorded at console.

16. Radio System - AM/FM - A passive audio system consisting of a broadcast studio, transmitting station, and student radio receivers. The system uses designated AM/FM frequency bands for information transmission.

17. Radio System with Responders - A multi-channel two-way radio communication system that operates within UHF or VHF-FM frequency bands limiting broadcast ranges. Network may be open or use encoding/decoding techniques or responders for individual channel privacy.

18. Telephone System - A telephone system with switching matrix capability that allows multiple station two-way audio communication at two or more remote locations.

Audio-Visual Systems

19. Carrel - A small enclosure or alcove incorporating a desk, can be used by one or two trainees and can be equipped with AV equipment or tools or print materials or a combination of these.

20. Dial Access Information Retrieval System - Audio/Video - Dial access information retrieval is an electronic system for distributing audio and/or visual materials and programs which are stored in a location remote from where they are dialed and received.

21. Filmstrip Projection System with Audio - A sound filmstrip projector represents a family of audio-visual devices using single frame visual filmstrips with sound on magnetic tape or records. Visuals and sound may be manually or automatically synchronized. Commercial equipment options include front or rear screen projection, remote and stop action capability, and cartridge loading models.

22. Microform with Audio - Microimagery, such as microfilm, used as a medium of instruction with audio tape or disc, etc.

23. Motion Picture Projection System - 16MM and Super 8MM Films - A motion picture projection system using professionally or locally prepared 16mm or S-8mm sound motion picture films for training. Appropriate 16mm or S-8mm projector and projection screen are included.

24. Sound Slide Projection System - A system for presenting information by means of an audio tape and a series of synchronized projected visual slides.

25. Teaching Machine - Still Visual/Audio - An individualized instruction system composed of programmed instruction still frames, such as large step multiple choice or fixed linear sequence, and/or synchronized sound, and a manually controlled device to display the audio and/or visual information.

26. Teaching Machine - Motion Visual/Audio - An individualized instruction system composed of programmed instruction motion frames, such as large step multiple choice or fixed linear sequence, and/or synchronized sound, and a manually controlled device to display the audio and/or visual information.

27. Televideo System - A telecommunication system that allows audio and visual two-way communication between two or more remote locations.

28. <u>Television - Cable (CATV)</u> - A hybrid CCTV system offering selective, multiple channel, encoded programming to cable network patrons. A typical system consists of a signal receiving antenna system for the master station and relay of amplified signal channels via area substations to system subscribers. Programming may also be generated and transmitted between substations offering multiple options for conference or training. Programs are encoded for privacy and control of viewing audience.

29. <u>Television - Cartridge (CTV)</u> - A cartridge television system (CTV) consists of packaged video tape programs, video recorder, playback and display units, and control equipment offering high selectivity and availability for individualized programming. Program cartridges may be prerecorded, locally produced, or recorded off-the-air.

30. <u>Television - Closed Circuit (CCTV)</u> - CCTV is an electronic transmission system for images and sound using a coaxial cable distribution system. System design includes one or more studios or control rooms, a signal distribution center, and signal distribution cables terminating in reception areas equipped with receiver/monitors. Off air, live or video taped programs may be used.

31. <u>Television - Non-Magnetic Video Disc System</u> - An experimental form of television, similar in function to cartridge television, in which the program is encoded on a thin plastic disc, distributed to users where it is rotated at high revolutions per minute on a player which reads the data and sends program signals into the antenna terminals of a standard color television receiver. Random access capability.

32. <u>Computer</u> - A programmable electronic device that can store, retrieve, and process data. It may manage and display information to a student, accept student responses, provide feedback, perform calculations, etc.

33. <u>Demonstrator</u> - A low fidelity simulator that demonstrates manipulative principles, movement in time or space, steps of a procedure, etc.

34. <u>Mock-up and Panel</u> - A training aid used to demonstrate relative shape, size, composition or function of an object or system display. It may have moving parts, such as dials, switches, levers, etc., or have non-moving parts, such as cutaway or layout models, etc.

35. <u>Operational Equipment</u> - A unit of or the entire equipment used on the job for training purposes where extreme fidelity is required.

36. <u>Physiological Trainers (Hostile Environment) Auditory</u> - training devices designed to place controlled stress on the human hearing system through use of a physiologically and/or psychologically adverse sound environment, to enable a trainee to learn to function in this adverse environment.

37. Physiological Trainers (Hostile Environment) Visual - A training device designed to place controlled stress on the human visual system, through the use of physiologically and/or psychologically adverse or low threshold visual signals, to enable a trainee to learn to function in this adverse environment.

38. Physiological Trainers (Hostile Environment) Surface and Internal Senses - A broad category of training devices designed to provide the cutaneous, kinesthetic and olfactory sensors with physiologically and/or psychologically adverse signals, to enable a trainee to function in adverse pressure, temperature, pain or disorientating motion environments.

MEDIA RELATED VARIABLES

STIMULI CHARACTERISTICS

Medium of Stimuli Presentation

1. Visual Cues - Signals received through the sense of sight.

2. Audio Cues - Signals received through the sense of hearing.

3. Tactile Cues - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.

4. External Stimulus Motion Cues - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

5. Internal Stimulus Motion Cues - The sensations felt by a person when he moves his arm, leg, fingers, etc.

6. Olfactile Cues - Signals received through the sense of smell.

7. Gustatile Cues - Signals received through the sense of taste.

Visual Form

8. Visual Alphanumeric - Words and/or numbers presented visually.

9. Visual Symbolic - Symbols presented graphically.

10. Visual Graphic - Two-dimensional figures, such as maps, graphs, mathematical curves, etc., presented visually.

11. Visual Pictorial - Two-dimensional images, such as photographs, drawings, etc., presented visually.

12. Visual Solid Object - A three-dimensional image or reality that is viewed from exterior perspectives.

13. Visual Environment - A three-dimensional image or reality that is viewed from inside.

Visual Movement

14. Visual Still - A static visual field, as with a still photograph, drawing or printed page.

15. Visual Limited Movement - A basically static visual field with elements that can be made to move, as with an animated transparency or simple panel with switches that move.

16. Visual Full Movement - A visual field in which all elements can move, as with a motion picture, flight simulator, or operational aircraft.

17. Visual Cyclic Movement - A visual field which moves through a fixed sequence and then repeats the sequence in a repetitive manner, as with a film loop.

Visual Spectrum

18. Black and White - A visual field composed of either black or white elements, as with the printed page or line drawings.

19. Gray Scale - A visual field composed of black, white and continuous gradations of gray, as with a black and white photograph or television picture.

20. Color - A visual vield composed of various segments of the visual spectrum, as with color television or motion pictures.

Visual Scale

21. Exact Scale - Actual visual field or a one-to-one replication of that field as with a full-sized mock-up, simulator, or operational system.

22. Proportional Scale - A representation of reality in other than full scale, such as a scaled model map or photograph.

Visual Contrast

23. Dim - A visual object which blends in with its background, i.e., there is a small or no luminance difference between an object and its background.

24. Bright - A visual object which is brighter than its background, i.e., there is a large luminance difference between an object and its background.

Audio Sources

25. Tonal Sound - A very limited source of sound or noise which is used, rather than speech, for signaling or warning, e.g., horns, whistles, sirens, bells, buzzers, etc.

26. Voice Sound - A limited source of sound which enables spoken words to be used as the medium of communications, but not suited to more demanding tasks, such as music or sound recognition exercises.

27. Full Sound - A source of sound that contains all the significant elements of the sound and is suited to the demanding task of sound recognition exercises.

28. Ambient Sound - A complex sound environment with sounds emanating from various sources and from various directions, including background noise and task significant sounds.

Audio Stimuli Intensity

29. Weak - Audio stimuli presented to the trainee which have weak intensity.

30. Strong - Audio stimuli presented to the trainee which have strong intensity.

Stimuli Presentation

31. Static - A unitary stimuli situation, i.e., stimuli are presented to the trainee "all at once", e.g., batch presentations.

32. Dynamic-Ordered - A sequential stimuli situation, i.e., stimuli are presented to the trainee sequentially or in an ordered manner over time.

33. Dynamic-Random - A non-sequential stimuli situation, i.e., stimuli are presented to the trainee randomly over time.

Stimuli Presentation Rate

34. Slow Rate - A slow rate or speed of presentation of stimuli to the trainee, allowing the trainee a long or maximum stimulus analysis time.

35. Fast Rate - A fast rate or speed of presentation of stimuli to the trainee, allowing the trainee a short or minimum stimulus analysis time.

Number of Channels or Sources

36. Limited - A small number of sources, channels, or instruments through which stimuli are presented to the trainee.

37. Unlimited - A multiple number of sources, channels, or instruments through which stimuli are presented to the trainee.

Stimuli Distribution

38. Individual - All information is presented directly to one individual trainee.

39. Group - Information is presented to a group of trainees, allowing only indirect access to the information for an individual.

MEDIA SELECTION MATRIX

TRAINING EQUIPMENT & MATERIALS

STIMULI VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	
2													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1		
3																																	1	1	1			1
4																																			1			1
5																			1														1	1	1			1
6																																			1			1
7																																			1			1
8	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1		1	1	1	1	1			1			
9	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1		1	1	1	1	1			1			
10	1		1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1		1	1	1	1	1			1			
11		1		1	1		1		1		1	1							1	1	1		1	1	1	1	1	1	1	1	1				1		1	
12																			1														1	1	1		1	
13																																	1		1		1	
14	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1		1	1							1			1			
15																																1	1	1	1		1	
16																			1	1			1			1	1	1	1	1	1				1		1	
17												1							1	1			1	1	1	1					1		1		1		1	
18	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1		1	1	1	1	1		1	1		1	
19		1		1	1		1		1			1							1	1	1		1	1	1	1	1	1	1	1	1			1	1		1	
20	1	1		1	1		1		1		1	1							1	1	1		1	1	1	1	1	1	1	1	1		1	1	1		1	
21				1															1														1	1	1		1	
22	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	
23									1			1							1	1	1		1	1	1	1	1	1	1	1	1				1		1	

(CON'T) MEDIA SELECTION MATRIX

TRAINING EQUIPMENT & MATERIALS

STIMULI VARIABLES CONT'D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
24	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	
25																																		1	1	1		
26														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1		
27													1	1	1	1	1		1	1	1	1	1	1				1	1	1	1				1	1		
28													1	1	1				1		1	1		1											1	1		
29													1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1	1				1	1		
30													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		
31	1	1	1	1	1	1	1	1	1	1	1	1							1	1	V	V		V	V							V		1	1	1	1	1
32		1							1			1	1	1	1	1	1		1	1	1	A	1	1	1	1		1	1	1	1	V	V	V	1	1	1	1
33		1												1	1	1	1	1	1	1	A	A	1	A	A	1	1	1	1	1	1	V		V	1	1	1	1
34		1							1			1	1	1	1	1	1	1	1	1	1	A	1	1	1	1		1	1	1	1	1			1	1	1	1
35		1											1	1	1	1	1	1	1	1	A	A	1	A				1	1	1	1	1			1	1	1	1
36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
37																		1															1		1	1	1	1
38	1	1	1	1	1	1	1	1		1			1	1	1	1	1	1	1	1		1			1	1	1	1	1	1	1	1	1	1	1	1	1	1
39		1		1					1		1	1	1	1		1		1	1		1		1	1				1	1	1	1	1	1	1	1	1	1	1

A = Audio Only V = Visual Only

MEDIA RELATED VARIABLES

RESPONSE CHARACTERISTICS

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.

2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.

3. Overt Response - Manipulative Acts - A response which the trainee expresses in an observable (manipulative) manner, such as the small movements of dials, switches, keys, or small adjustments to instruments or the large movements of levers, wheels or use of hand held tools.

4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continuously controlling a constantly changing system, e.g., steering an automobile.

5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

Intensity of Response

6. Weak - Responses made by the trainee with weak intensity.

7. Strong - Responses made by the trainee with strong intensity.

Response Implementation

8. Static - A unitary response situation, i.e., responses are made by the trainee "all at once".

9. Dynamic-Ordered - A sequential response situation, i.e., responses are made by the trainee sequentially or in an ordered manner over time.

10. Dynamic-Random - A non-sequential response situation, i.e., responses are made by the trainee randomly over time.

Required Response Rate

11. Slow Rate - A slow rate or speed of trainee response, i.e., a rate which allows the trainee a long or maximum response time.

12. Fast Rate - A fast rate or speed of trainee response, i.e., a rate which allows the trainee a short or minimum response time.

Number of Response Channels

13. Limited - A limited number of sources, channels, or instruments through which required responses are made by the trainee.

14. Unlimited - An unlimited number of sources, channels, or instruments through which responses are made by the trainee.

Response Distribution

15. Individual - One individual trainee makes the required response.

16. Group - A group of trainees make the required response.

MEDIA SELECTION MATRIX

TRAINING EQUIPMENT & MATERIALS

RESPONSE VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1														1	1		1	1	1								1	1	1	1	1	1			1			
2						1		1											1						1	1						1			1			
3		1																	1														1	1	1			
4																																1	1	1	1			
5		1		1		1		1						1	1		1	1	1									1		1	1	1	1	1	1			
6														1	1		1	1	1								1	A	1	A	A		1	1	1			
7														1	1		1	1	A								1	A	1	A	A	A	1	1	1			
8						1		1						1	1		1	1	1						1	1	1	1	1	1	1	AW	1	1	1			
9		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	A-	1	1	1			
10		1				1		1						1	1		1	1	1								1	1	1	1	1	A-			1			
11		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
12		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
13		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
14																																	1		1			
15		1		1		1		1						1	1		1	1	1						1	1	1	1	1	1	1	1	1	1	1			
16														1				1										1	1	1	1	1	1	1	1			

A = Audio Only   AW = Audio and Written Only   A- = All but Audio

MEDIA RELATED VARIABLES

INFORMATION FEEDBACK LOGIC

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.

2. Aural - Feedback presented aurally by means of a display to the trainee.

3. Written Form - Feedback presented to the trainee in written form.

4. Face-to-Face Communication - Feedback presented by direct verbal means to the trainee.

5. Indirect Communication - Feedback presented by indirect verbal means, such as by intercom, telephone, or radio link.

6. Tactile - Feedback presented to the trainee through the sense of touch, including sensations related to texture, shape, size, or vibration of the skin.

7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.

8. Olfactile - Feedback presented to the trainee through the sense of smell.

9. Gustatile - Feedback presented to the trainee through the sense of taste.

Source of Feedback

10. Intrinsic F - Information or cues built into the system from which the trainee interprets feedback information.

11. Extrinsic F - Information or cues not inherent in the trainee action or system operations but is supplied by an external source.

Type of Feedback

12. Research Correctness (Rcr) - Information about the correctness or incorrectness of trainee's response, when several response alternatives are possible and the correct choice is not known to the trainee in advance. (Also known as augmented feedback.)

13. Response Correctness (Rcf) - Information provided to the trainee (or others who need to know about his performance) that he has in fact performed an operation, but does not say anything about the longer range consequences of the action taken.

14. Response Consequences (Rcn) - Information about the consequences of the action taken. It confirms the response made by the trainee, and the correctness of a response can be inferred only from its consequences. May also serve to cue the trainee to perform the next response in sequence.

15. System Status (Rss) - Information about the condition of one's own or another system or the external environment, on the basis of which a trainee or team must act. Information is not necessarily (or even frequently) the immediate consequence of or follow-on to a specific trainee/team action; it may reflect system events that have been put in motion by much earlier trainee actions. Provides information that regulates trainee and system actions in the sense that when a particular status condition occurs, the trainee must often take action to maintain the integrity of his system.

Feedback Distribution

16. Individual - Feedback is presented to one individual trainee.

17. Group - Feedback is presented to a group of trainees, allowing only indirect access for an individual.

MEDIA SELECTION MATRIX

TRAINING EQUIPMENT & MATERIALS

RESPONSE VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1		1				1						1							1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
2													1	1	1				1		1	1	1	1	1	1		1	1	1	1			1	1			
3		1				1		1			1	1							1						1							1			1			
4																																			1			
5															1		1	1									1	1		1					1			
6																																			1			
7																			1														1	1	1			
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10		1				1		1			1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
11	1		1	1	1		1		1	1						1				1																1	1	1
12		1				1		1			1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1			1			
13																	1	1									1	1		1		1	1	1	1			
14								1									1	1									1	1		1		1	1	1	1			
15																		1										1		1		1	1		1			
16		1				1		1					1	1	1			1	1			1			1	1	1	1	1	1	1	1	1	1	1			
17		1									1	1	1	1			1	1	1		1		1	1				1	1	1	1	1	1	1	1			

APPENDIX B

METHOD

DESCRIPTIONS OF TRAINING METHODS--CODING EXPLANATIONS

1. Who is Performing?

   a. I=Instructor
      S=Student
      M=Media
   b. I_1, S_1, or M_1=First individual or group
      I_2, S_2, or M_2=Second individual or group
      Etc.
   c. (N+)=Expected number of individuals or more
      (N-)=Expected number of individuals or less (N=Number in cell)

2. How Many Times is He Performing?

   a. 1=Once
      2=Twice
      Etc.
      N=Number of times

3. Where is His Performance in the Sequence?

   a. 1=First
      2=Second
      1,3=First and third
      Etc.
      ....=Cyclical sequence

TRAINING METHOD: LECTURE-STANDARD (1)

DESCRIPTION: A semiformal discourse in which the instructor presents a series of events, facts, concepts, or principles; explores a problem; or explains relationships. Trainees participate in a lecture mainly as listeners. A lecture is basically a means of "telling" trainees information they need to know. Not all talking done by an instructor during a class period can be termed a lecture, the term describes a more formal presentation used to achieve an instructional objective.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1	S_1 (15+)	I_1
HOW MANY TIMES IS HE PERFORMING?	1	1	1
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	100	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	100	100	100

TRAINING METHOD: LECTURE-TEAM TEACH (2)

DESCRIPTION: A semiformal discourse in which two (or more) instructors present a series of events, facts, concepts, or principles; explore a problem; or explain relationships. Trainees participate in a lecture mainly as listeners. A lecture is basically a means of "telling" trainees information they need to know. Not all the talking done by the instructors during a class period can be termed a lecture, the team describes a more formal presentation used to achieve an instructional objective.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 I_2	S_1 (15+)	I_1
HOW MANY TIMES IS HE PERFORMING?	2 1	1	1
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1, 3 2	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	60 40	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	40 60	100	100

TRAINING METHOD: CONFERENCE-DIRECTED DISCUSSION (3)

DESCRIPTION: Group discussion techniques are used to reach instructional objectives. These techniques include questions, answers, and comments from the instructor in combination with answers, comments, and questions from the trainees, and are directed toward attainment of learning goals. The objective in directed discussion is to help trainees acquire better understanding and the ability to apply known facts, principles, concepts, policies, or procedures, or to provide trainees with an opportunity to apply their knowledge. The function of the instructor is to guide the discussion in such a way that the facts, principles, concepts, or procedures are clearly articulated and applied.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 (10-)	S_1 (10-) I_1	I_1 S_1 (10-)
HOW MANY TIMES IS HE PERFORMING?	N N	N N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1, 3,... 2, 4,...	1, 3,... 2, 4,...	1, 3,... 2, 4,...
WHAT IS HIS DEGREE OF CONTROL? (%)	60 40	50 50	60 40
HOW LONG IS HIS PERFORMANCE? (% TIME)	60 40	50 50	60 40

TRAINING METHOD: CONFERENCE-SEMINAR (4)

DESCRIPTION: Group discussion techniques are used to reach instructional objectives. These techniques include questions, answers, and comments from the instructor in combination with answers, comments, and questions from the trainees, and are directed toward attainment of learning goals. The purpose of the seminar is to find an answer to a question or a solution to a problem. The instructor does not have an answer or a solution; in fact there is no known best or correct solution. Rather, he is seeking an answer, and he uses the group to develop one. The primary functions of the instructor are to describe the problem as he understands it and to encourage free and full participation in a discussion aimed at (1) identifying the real problem, (2) gathering and analyzing data, (3) formulating and testing hypotheses, (4) determining and evaluating alternative courses of action, (5) arriving at conclusions, and (6) making recommendations to support or arrive at a solution or a decision.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 (10-)	S_1 (10-) I_1	I_1 S_1 (10-)
HOW MANY TIMES IS HE PERFORMING?	N N	N N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1, 3,... 2, 4,...	1, 3,... 2, 4,...	1, 3,... 2, 4,...
WHAT IS HIS DEGREE OF CONTROL? (%)	50 50	50 50	50 50
HOW LONG IS HIS PERFORMANCE? (% TIME)	50 50	50 50	50 50

TRAINING METHOD: DEMONSTRATION (5)

DESCRIPTION: The instructor actually performs an operation or does a job, thereby showing the trainee what to do and how to do it; he then uses explanations to point out why, where, and when it is done. Usually, the trainee is expected to be able to repeat the job or operation after the demonstration.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1	S_1 (10-)	M_1 I_1
HOW MANY TIMES IS HE PERFORMING?	1 1	N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	60 40	100	40 60
HOW LONG IS HIS PERFORMANCE? (% TIME)	60 40	100	40 60

TRAINING METHOD: PERFORMANCE-MANUAL-INDEPENDENT PRACTICE (6)

DESCRIPTION: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In independent practice, trainees work individually and at their own rate.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1	S_1	M_1
HOW MANY TIMES IS HE PERFORMING?	N	N	N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	100	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	100	100	100

TRAINING METHOD: PERFORMANCE-MANUAL-STUDENT TUTOR (7)

DESCRIPTION: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In the student tutor method, trainees are paired and members of each pair perform alternately as instructor and trainee.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1 S_1 S_2	S_2 S_1	M_1 S_1 S_2
HOW MANY TIMES IS HE PERFORMING?	N N N	N N	N N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1, 3, 5, 7,... 2, 6,... 4, 8,...	1 2	1, 3, 5, 7,... 2, 6,... 4, 8,...
WHAT IS HIS DEGREE OF CONTROL? (%)	50 25 25	50 50	50 25 25
HOW LONG IS HIS PERFORMANCE? (% TIME)	50 25 25	50 50	50 25 25

TRAINING METHOD: PERFORMANCE-MANUAL-GROUP PRACTICE (8)

DESCRIPTION: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In group performance, a group of trainees perform an operation or function involving teamwork.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1 S_1 (5-)	S_1 (5-)	M_1 S_1 (5-)
HOW MANY TIMES IS HE PERFORMING?	N N	N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	50 50	100	50 50
HOW LONG IS HIS PERFORMANCE? (% TIME)	50 50	100	50 50

TRAINING METHOD: PERFORMANCE-MANUAL-GROUP CONTROLLED PRACTICE (9)

DESCRIPTION: A method in which the trainee is required to perform under controlled conditions, the operation, skill, or movement being taught. Performance is learning by doing. In group controlled practice, trainees work together at the rate set by the instructor, step by step and "by the numbers".

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1 (5-)	S_1 (5-)	M_1 I_1 S_1 (5-)
HOW MANY TIMES IS HE PERFORMING?	N N N	N	N N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1	1 2 3
WHAT IS HIS DEGREE OF CONTROL? (%)	40 30 30	100	50 30 20
HOW LONG IS HIS PERFORMANCE? (% TIME)	20 40 40	100	50 20 30

TRAINING METHOD: Programmed Instruction (10)

DESCRIPTION: A method of self-instruction in which the trainee works through a carefully sequenced and pretested series of steps leading to the acquisition of knowledge or skills representing the instructional objectives. The trainee proceeds through the program at his own rate, responds actively (or covertly) to each step in the sequence, and receives immediate feedback on the correctness of his response before proceeding to the next step. Programs are usually designed to permit the trainee to master the desired knowledge or skills.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1	S_1	M_1
HOW MANY TIMES IS HE PERFORMING?	N	N	N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	100	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	100	100	100

TRAINING METHOD: STUDY ASSIGNMENT-INDIVIDUAL STUDY (11)

DESCRIPTION: In the study assignment method, the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or prescribes problems and exercises for the practice of a skill. In independent study, the trainee carries out the assignment without instructor assistance or direct guidance.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1	S_1	S_1 I_1
HOW MANY TIMES IS HE PERFORMING?	I' N N	N	N 1
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	20 30 50	100	70 30
HOW LONG IS HIS PERFORMANCE? (% TIME)	5 40 55	100	70 30

TRAINING METHOD: STUDY ASSIGNMENT-SUPERVISED STUDY (12)

DESCRIPTION: In the study assignment method, the instructor assigns readings in books, periodicals, manuals, or handouts; requires the completion of a project or research paper; or prescribes problems and exercises for the practice of a skill. In supervised study, the trainee carries out the assignment with an instructor available for guidance and assistance.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1	S_1 I_1	S_1 I_1
HOW MANY TIMES IS HE PERFORMING?	N N N	N N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1, 4, 6,... 2 3, 5, 7,...	1 2	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	30 20 50	80 20	30 70
HOW LONG IS HIS PERFORMANCE? (% TIME)	20 30 50	90 10	70 30

TRAINING METHOD: TUTORING (13)

DESCRIPTION: An instructor works directly with an individual trainee. The method may involve exposition, demonstration, questioning, coaching, or guided practice.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1	S_1 I_1	I_1 M_1 S_1
HOW MANY TIMES IS HE PERFORMING?	N N N	N N	N N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1 2	1 2 3
WHAT IS HIS DEGREE OF CONTROL? (%)	60 10 30	70 30	60 10 30
HOW LONG IS HIS PERFORMANCE? (% TIME)	50 10 40	70 30	50 10 40

TRAINING METHOD: CASE STUDY (14)

DESCRIPTION: Involves in-depth group discussion of real-life situations. It requires reading, study, analysis, discussion, and free exchange of ideas as well as decision making and the selling of decisions to others. A case report is distributed to trainees. The report contains a factual and accurate picture, based on firsthand observation, of a situation that portrays people acting, interacting, and reacting. Trainees study the case report and discuss it in depth.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1 S_1 (15-)	S_1	S_1 (15-)
HOW MANY TIMES IS HE PERFORMING?	1 N	N	N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	20 80	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	20 80	100	100

TRAINING METHOD: INCIDENT METHOD (15)

DESCRIPTION: A variation of the case method in which only a brief sketch of the climax of a case is presented. Trainees are given a few minutes to study the incident and attempt to determine the information they need to find out what is going on. Trainees then get these facts by asking questions of the leader. Time is usually limited, and questions must be of the type that can be answered "yes" or "no", or by a simple factual statement. The group then determines the nature of the problem and the decisions needed to solve it. Each member writes an individual decision with supporting reasons. Group discussion of the case in general and the decisions reached follows.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1 I_1 S_1 (15-)	S_1 (15-) I_1	S_1 (15-)
HOW MANY TIMES IS HE PERFORMING?	1 N N	N N	N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 3, 5,... 2, 4,...	1 2	1
WHAT IS HIS DEGREE OF CONTROL? (%)	10 40 50	70 30	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	10 30 60	70 30	100

TRAINING METHOD: ROLE PLAYING (16)

DESCRIPTION: A laboratory method of instruction that involves the spontaneous dramatization or acting out of a situation by two or more persons under the direction of a trainer. The dialog grows out of the situation developed by the trainees assigned to the parts. Each person acts his role as he feels it should be played. Other trainees serve as observers and critics. Following the enactment, the group engages in discussion.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 (4-) S_2 (30-)	S_1 (4-) I_1 S_2 (30-)	I_1 S_1 (4-) S_2 (30-)
HOW MANY TIMES IS HE PERFORMING?	1 N N	N N N	N N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1 2 3	1 2 3
WHAT IS HIS DEGREE OF CONTROL? (%)	30 50 20	50 30 20	40 30 30
HOW LONG IS HIS PERFORMANCE? (% TIME)	30 50 20	50 30 20	40 30 30

TRAINING METHOD: SENSITIVITY (LABORATORY OR T-GROUP) TRAINING (17)

DESCRIPTION: A deliberate effort to apply behavioral science to problems of motivation, communication, problem solving, and teamwork. Basically, sensitivity training is small-group interaction under stress in an unstructured group composed of learners and a trainer. The objective is behavioral change. To attain the objective, a permissive or supportive environment is established by the trainer. Participants are encouraged to act their own roles, receive feedback, examine their concepts of self, experiment with and practice new patterns of behavior, and learn how to maintain changed behavior back on the job.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 (5-)	S_1 (5-) I_1	I_1 S_1 (5-)
HOW MANY TIMES IS HE PERFORMING?	N N	N N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1 2	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	30 70	70 30	30 70
HOW LONG IS HIS PERFORMANCE? (% TIME)	30 70	70 30	30 70

TRAINING METHOD: GAMES (18)

DESCRIPTION: Games include a set of structured decision-making tasks typical of a real-life situation and provide a systematic means of observing and evaluating trainees' decisions. These, then, are fed back to the trainees so that they can judge their appropriateness. Most games are played by one or more teams, each composed of from one to twenty participants. There may or may not be interaction between teams. Games are usually played in periods-- an interval of time which may represent a month, a quarter, or a year. Trainees are given information in the form of reports or a scenario and allowed time to study the situation and make decisions. These decisions are processed either by a control group of judges or by a computer. The resulting data or scenario projections are returned to the team for analysis, and another decision.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1 (20-)	S_1 (20-)	S_1 (20-) M_1
HOW MANY TIMES IS HE PERFORMING?	N N N	N	N 1
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	10 30 60	100	70 30
HOW LONG IS HIS PERFORMANCE? (% TIME)	10 30 60	100	90 10

TRAINING METHOD: IN-BASKET EXERCISES (19)

DESCRIPTION: The in-basket situation is composed of a representative sample of a full year's performance in all aspects of a job. Trainees are given background materials, organization charts, policy manuals, financial statements, reports, and position papers to study before the exercise begins. Each trainee is then exposed to a structured array of memos, reports, letters, telephone calls, visits, and meetings. In his role as a manager, the trainee makes decisions on the incoming "mail." In each instance he commits himself in writing to specific courses of action. Time limits are established to introduce realism and cause stress. The decision-making phase is followed by discussion and critique of the actions taken and decisions reached. All actions are analyzed, evaluated, and fed back to participants.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 M_1 S_1 (20-)	S_1 (20-) I_1	I_1 S_1 (20-)
HOW MANY TIMES IS HE PERFORMING?	1 N N	N N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2 3	1 2	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	10 40 50	80 20	60 40
HOW LONG IS HIS PERFORMANCE? (% TIME)	10 40 50	80 20	60 40

TRAINING METHOD: BRAINSTORMING (20)

DESCRIPTION: A small, carefully selected group is given a "how to" question or problem and is asked to produce as many ideas or solutions as they can generate. Usually a time limit is set. The technique of free association is encouraged. Quantity of ideas or solutions takes precedence over quality. Judgments about the worth of ideas or solutions are deliberately postponed until a later time. Ideas are written on a chalkboard or flip chart as fast as they are called out.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1' (10-)	S_1 (10-)	S_1 (10-)
HOW MANY TIMES IS HE PERFORMING?	1 N	N	N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1
WHAT IS HIS DEGREE OF CONTROL? (%)	10 90	100	100
HOW LONG IS HIS PERFORMANCE? (% TIME)	10 90	100	100

TRAINING METHOD: COMMITTEES (21)

DESCRIPTION: A group of trainees, ranging in size from three to seven, is given a special assignment in the form of a problem. The group is asked to investigate the problem, reach conclusions, and recommend a solution or a course of action. The committee may produce a report which is often presented orally to the larger group.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 (7-)	S_1 (7-)	I_1 S_2 (20-)
HOW MANY TIMES IS HE PERFORMING?	1 N	N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	10 90	100	70 30
HOW LONG IS HIS PERFORMANCE? (% TIME)	10 90	100	60 40

TRAINING METHOD: FIELD TRIPS (22)

DESCRIPTION: A carefully planned visit or tour to a place away from the training activity. The purpose of the trip is to provide firsthand observation of objects, processes, operations, and situations not transportable to, or reproducible in, the training facility. The field trip may take less than an hour when it involves a visit to an adjoining plant, office, or shop; or it may consume several days or weeks as would be the case with a visit to a distant plant or an overseas installation.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	M_1	S_1 (20-)	M_1 S_1 (20-)
HOW MANY TIMES IS HE PERFORMING?	N	N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	100	100	50 50
HOW LONG IS HIS PERFORMANCE? (% TIME)	100	100	50 50

TRAINING METHOD: PANELS (23)

DESCRIPTION: Three to ten people, under the direction of a moderator, present their views on a particular subject or problem, or present assigned phases of a broad topic. Usually, panelists represent different kinds of expertise, experience, or perspectives. Often they are drawn from operating and staff elements. At times experts from outside the enterprise are invited to participate. Sometimes trainees themselves serve as members of panels. Following the presentations by the panelists, trainees are encouraged to participate through questions directed to individual panelists.

METHOD VARIABLES	STIMULUS	RESPONSE	FEEDBACK
WHO IS PERFORMING?	I_1 S_1 I_2 (10-)	S_2 (20+)	I_3 S_2 (20+)
HOW MANY TIMES IS HE PERFORMING?	N N	N	N N
WHERE IS HIS PERFORMANCE IN THE SEQUENCE?	1 2	1	1 2
WHAT IS HIS DEGREE OF CONTROL? (%)	60 40	100	60 40
HOW LONG IS HIS PERFORMANCE? (% TIME)	30 70	100	30 70

FUNCTIONAL CONTEXT VARIABLES

ROLE OF ELEMENT - The social function performed by the trainee within the system's operational context.

1. Supervisory - The trainee's function is unequal to functions being performed by other individuals; the role is basically one of overseeing or directing.

2. Team Performance - The trainee's function is equal to functions being performed by other individuals; the function is basically one of teamwork and cooperation.

3. Individual Performance - The trainee's function is one of performing alone, usually without supervision or team assistance.

FUNCTION PERFORMED IN ROLE - The primary actions performed within each role.

4. Mental - An action occurring or experienced in the trainee's mind, as contrasted with overt physical activity.

5. Physical - An overt bodily action performed by the trainee.

6. Perceptual - An action by the trainee involving perception or observation.

7. Communicative - An action by the trainee in which he transmits either a written or verbal message.

STABILITY OF FUNCTION - The function's state, quality, or degree of being constant overtime.

8. Unstable - The trainee's function is not constant or regular, it is characterized by continual change and fluctuation.

9. Stable - The trainee's function has little change or fluctuation over time.

PHYSICAL CONTEXT - The significance of the physical environment upon performance of the task.

10. Low Impact - The physical environment has little or no significant impact on performance of the task.

11. High Impact - The physical environment has a large or significant impact on performance of the task.

PSYCHOLOGICAL IMPACT - The significance of the psychological environment upon performance of the task.

12. Low Impact - The psychological environment has little or no significant impact on performance of the task.

13. High Impact - The psychological environment has a large or significant impact on performance of the task.

METHOD SELECTION MATRIX

	METHOD / Functional Context Variables	1 Lecture Standard	2 Lecture-Team Teach	3 Conference - Directed Discuss.	4 Conference - Seminar	5 Demonstration	6 Performance-Man. Ind. Practice	7 Performance-Man. Student Tutor	8 Performance-Man. Group Practice	9 Performance-Man. Group Contr. Prac.	10 Programmed Instruction	11 Study Assignment Individual Study	12 Study Assignment Supervised Study	13 Tutoring	14 Case Study	15 Incident Method	16 Role Playing	17 Sensitivity Training	18 Games	19 In-Basket Exercise	20 Brainstorming	21 Committees	22 Field Trips	23 Panels
Role of Element	Supervisory 1																X	X	X	X				
	Team Performance 2			X	X			X	X	X					X	X			X			X		
	Individual Performance 3	X	X			X	X				X	X	X	X		X		X		X	X		X	X
Function Performed in Role	Mental 4	X	X	X	X				X		X	X	X	X	X	X	X	X	X	X	X	X		X
	Physical 5					X	X	X	X	X				X										
	Perceptual 6								X		X			X									X	
	Communicative 7			X				X	X	X				X	X	X	X	X	X			X		X
Stability of Function	Unstable 8		X		X								X	X	X	X	X	X	X	X	X			
	Stable 9	X		X		X	X	X	X	X	X	X										X	X	X
Physical Context	Low Impact 10	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X		X
	High Impact 11					X	X	X	X	X				X									X	
Psychological Context	Low Impact 12	X	X			X				X			X	X								X		X
	High Impact 13			X	X		X	X	X		X	X		X	X	X	X	X	X	X	X		X	

APPENDIX C

FUTURE RESEARCH RESOURCE VARIABLES

1. Method Related Variables
   a. Stimuli Characteristics (C-2-3)
   b. Response Characteristics (C-4-5)
   c. Information Feedback Logic (C-6)
2. Content Related Variables
   a. Stimuli Characteristics (C-7-8)
   b. Response Characteristics (C-9-10)
   c. Information Feedback Logic (C-11-12)
3. Information Structure Related Variables
   a. Stimuli Characteristics (C-13-14)
   b. Response Characteristics (C-15-16)
   c. Information Feedback Logic (C-17-18)

METHOD RELATED VARIABLES

STIMULI CHARACTERISTICS

Medium of Stimuli Presentation

1. Visual Cues - Signals received through the sense of sight.

2. Audio Cues - Signals received through the sense of hearing.

3. Tactile Cues - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.

4. External Stimulus Motivation Cues - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

5. Internal Stimulus Motion Cues - The sensations felt by a person when he moves his arm, leg, fingers, etc.

6. Olfactile Cues - Signals received through the sense of smell.

7. Gustatile Cues - Signals received through the sense of taste.

Number of Channels or Sources

8. Limited - A small number of sources, channels, or instruments through which stimuli are presented to the trainee.

9. Unlimited - A multiple number of sources, channels, or instruments through which stimuli are presented to the trainee.

Stimuli Pacing

10. Self-paced - Stimuli are only presented upon the trainee's request.

11. Forced-pace - Stimuli are presented at some predetermined rate, frequency of change, etc.

Stimuli Distribution

12. Individual - All information is presented or displayed directly to one individual trainee.

13. Group - Information is presented or displayed to a group of trainees, allowing only indirect access to the information for an individual.

Response Criterion

14. Determinate - The response criterion has a fairly explicit or implicit response requirement as a direct reflection of the training or system requirement, and makes the stimulus (visual, audio, etc.) possess a certain or determinate value or payoff for the trainee.

15. Indeterminate - The response criterion is highly dependent on the trainee's interpretation of the response requirement, and makes the stimulus (visual, audio, etc.) possess an uncertain or indeterminate value or payoff for the trainee.

METHOD RELATED VARIABLES

RESPONSE CHARACTERISTICS

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.

2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.

3. Overt Response - Manipulative Acts - A response which the trainee expresses in an observable (manipulative) manner, such as the small movements of dials, switches, keys, or small adjustments to instruments or the large movements of levers, wheels or use of hand held tools.

4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continously controlling a constantly changing system, e.g., steering an automobile.

5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

6. Covert Response - A response which the trainee creates in his mind but does not express in an observable or audible manner.

Response Pacing

7. Self-paced - Responses are made by the trainee at his own rate.

8. Forced-pace - Responses are made by the trainee at some predetermined rate or frequency.

Response Distribution

9. Individual - All responses are expressed by one individual trainee.

10. Group - Responses are expressed by a group of trainees, allowing only indirect responses for an individual.

Response Determinancy

11. Determinant - A required response which can be specified in advance of the stimuli that calls the response out, i.e., the response is preprogrammed or determined before the operation begins.

12. Indeterminant - A required response which cannot be specified in advance of the stimuli that calls the response out, i.e., the response is highly dependent on the immediate stimuli situation and cannot be predicted in advance, hence is indeterminate.

METHOD RELATED VARIABLES

INFORMATION FEEDBACK LOGIC

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.

2. Aural - Feedback presented aurally by means of a display to the trainee.

3. Written Form - Feedback presented to the trainee in written form.

4. Face-to-Face Communication - Feedback presented by direct verbal means to the trainee.

5. Indirect Communication - Feedback presented by indirect verbal means, such as by intercom, telephone, or radio link.

6. Tactile - Feedback presented to the trainee through the sense of touch, including sensations related to texture, shape, size, or vibration of the skin.

7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.

8. Olfactile - Feedback presented to the trainee through the sense of smell.

9. Gustatile - Feedback presented to the trainee through the sense of taste.

Source of Feedback

10. Intrinsic F - Information or cues built into the system from which the trainee interprets feedback information.

11. Extrinsic F - Information or cues not inherent in the trainee action or system operations but is supplied by an external source.

Feedback Pacing

12. Self-paced - Feedback presented to the trainee only at his request.

13. Forced-pace - Feedback presented to the trainee at some predetermined rate, frequency, etc.

Feedback Distribution

14. Individual - Feedback is presented to one individual trainee.

15. Group - Feedback is presented to a group of trainees, allowing only indirect access for an individual.

CONTENT RELATED VARIABLES

STIMULI CHARACTERISTICS

Medium of Stimuli Presentation

1. Visual Cues - Signals received through the sense of sight.

2. Audio Cues - Signals received through the sense of hearing.

3. Tactile Cues - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.

4. External Stimulus Motion Cues - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

5. Internal Stimulus Motion Cues - The sensations felt by a person when he moves his arm, leg, fingers, etc.

6. Olfactile Cues - Signals received through the sense of smell.

7. Gustatile Cues - Signals received through the sense of taste.

Significance of Stimuli

8. Significant - The stimuli are consequential or important in terms of their meaning for problem solving, e.g., the identification of enemy bombers or missiles may direct the kind of weapons released against them.

9. Insignificant - The stimuli are inconsequential or unimportant in terms of their meaning for problem solving, e.g., identification of a reconnaissance aircraft may be less significant than the identification of an enemy bomber.

Relevancy of Stimuli

10. Relevant - Accurate, complete, or relevant stimuli which the trainee is cued to respond to because of his instructions or other system criteria.

11. Irrelevant - Inaccurate, distorted, incomplete or irrelevant stimuli which the trainee must discriminate from relevant stimuli, e.g., "clutter" or "noise".

Stimuli Cost

12. Low - A low cost of securing information (visual, audio, etc. stimuli) to help make a decision e.g., little delay or effort, or loss of equipment or men.

13. High - A high cost of securing information (visual, audio, etc. stimuli to help make a decision, e.g., much delay or effort or loss of equipment and men.

Stimuli Similarity

14. Similarity - Stimuli presented to the trainee which resemble other stimuli.

15. Variability - Stimuli presented to the trainee which vary or differ from other stimuli.

CONTENT RELATED VARIABLES

RESPONSE CHARACTERISTICS

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.

2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.

3. Overt Response - Manipulative Acts - A response which the trainee expresses in an observable (manipulative) manner, such as the small movements of dials, switches, keys, or small adjustments to instruments or the large movements of levers, wheels or use of hand held tools.

4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continuously controlling a constantly changing system, e.g., steering an automobile.

5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

6. Covert Response - A response which the trainee creates in his mind but does not express in an observable or audible manner.

Response Similarity

7. Similarity - Responses made by the trainee which resemble other responses.

8. Variability - Responses made by the trainee which vary or differ from other responses.

Significance of Responses

9. Significant - The responses are consequential or important in terms of their meaning for problem solving, e.g., pressing a "fire" button after identification on any enemy aircraft.

10. Insignificant - The responses are inconsequential or unimportant in terms of their meaning for problem solving, e.g., social communication among team members, which are not related to task accomplishment.

Relevancy of Responses

11. Relevant - Accurate, complete, or relevant responses which the trainee expresses, according to his instructions or other system criteria.

12. Irrelevant - Inaccurate, distorted, incomplete, or irrelevant responses which the trainee expresses, e.g., a response which gives altitude information only, but which was to include both altitude and azimuth information.

Response Cost/Value or Payoff Relationship

13. Low Cost/High Value - The relationship between response cost and value, where the cost of responding a particular way is low and the value is high, e.g., a decision to retreat from one area to help reinforce another, may mean that one will lose some men and equipment in the area from which they are retreating, but will save more men and equipment in the long run by reinforcing the other area.

14. High Cost/Low Value - The relationship between response cost and value, where the cost of responding a particular way is high and the value is low e.g., a decision to delay an advance may cost more lives and loss of equipment than a decision to advance immediately.

CONTENT RELATED VARIABLES

INFORMATION FEEDBACK LOGIC

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.

2. Aural - Feedback presented aurally by means of a display to the trainee.

3. Written Form - Feedback presented to the trainee in written form.

4. Face-to-Face Communication - Feedback presented by direct verbal means to the trainee.

5. Indirect Communication - Feedback presented by indirect verbal means, such as by intercom, telephone, or radio link.

6. Tactile - Feedback presented to the trainee through the sense of touch, including sensations related to texture, shape, size, or vibration of the skin.

7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.

8. Olfactile - Feedback presented to the trainee through the sense of smell.

9. Gustatile - Feedback presented to the trainee through the sense of taste.

Type of Feedback

10. Research Correctness (Rcr) - Information about the correctness or incorrectness of trainee's response, when several response alternatives are possible and the correct choice is not known to the trainee in advance. (Also known as augmented feedback.)

11. Response Correctness (Rcf) - Information provided to the trainee (or others who need to know about his performance) that he has in fact performed an operation, but does not say anything about the longer range consequences of the action taken.

12. Response Consequences (Rcn) - Information about the consequences of the action taken. It confirms the response made by the trainee, and the correctness of a response can be inferred only from its consequences. May also serve to cue the trainee to perform the next response in sequence.

13. System Status (Rss) - Information about the condition of one's own or another system or the external environment, on the basis of which a trainee or team must act. Information is not necessarily (or even frequently) the immediate consequence of or follow-on to a specific trainee/team action; it may reflect system events that have been put in motion by much earlier trainee actions. Provides information that regulates trainee and system actions in the sense that when a particular status condition occurs, the trainee must often take action to maintain the integrity of his system.

Feedback Specificity

14. Specific - Quanitative - Quanitative (outcome) information provided to the trainee, which states a relationship between the trainee's response and the desired correct response; for example, the percent error, the number of correct or incorrect responses, or rate data.

15. Nonspecific - Qualitative - Qualitative (outcome) information provided to the trainee about his performance; for example, "there were more correct responses than last time," "almost all ammunition was expended," etc.

16. Specific - Detailed - Detailed, fractionated categories of information or a wide range of feedback dimensions provided to the trainee about his performance.

17. Nonspecific - Nondetailed - Whole unfractionated categories of information or a narrow range of feedback dimensions provided to the trainee about his performance.

Properties of Feedback

18. Motivational - Feedback provided to the trainee which has motivational (stimulating, goal adjusting, and criteria selecting) properties; motivational feedback has few or no cue properties, i.e., feedback that neither informs the trainee of the nature or locus of his errors nor suggests how these might be corrected.

19. Directive - Feedback provided to the trainee which has informational or directive properties; directive feedback serves a guidance function to the trainee about his performance, i.e., feedback that informs the trainee of the nature and locus of his errors and suggests how these might be corrected.

INFORMATION STRUCTURE RELATED VARIABLES

STIMULI CHARACTERISTICS

<u>Medium of Stimuli Presentation</u>

1. <u>Visual Cues</u> - Signals received through the sense of sight.

2. <u>Audio Cues</u> - Signals received through the sense of hearing.

3. <u>Tactile Cues</u> - Signals received through the sense of touch, including sensations related to texture, size, shape, or vibration of the skin.

4. <u>External Stimulus Motion Cues</u> - The sensations felt by a person when he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

5. <u>Internal Stimulus Motion Cues</u> - The sensations felt by a person when he moves his arm, leg, fingers, etc.

6. <u>Olfactile Cues</u> - Signals received through the sense of smell.

7. <u>Gustatile Cues</u> - Signals received through the sense of taste.

<u>Stimuli Presentation</u>

8. <u>Static</u> - A unitary stimuli situation, i.e., stimuli are presented to the trainee "all at once", e.g., batch presentations.

9. <u>Dynamic-Ordered</u> - A sequential stimuli situation, i.e., stimuli are presented to the trainee sequentially or in an ordered manner over time.

10. <u>Dynamic-Random</u> - A non-sequential stimuli situation, i.e., stimuli are presented to the trainee randomly over time.

<u>Stimuli Presentation Rate</u>

11. <u>Slow Rate</u> - A slow rate or speed of presentation of stimuli to the trainee, allowing the trainee a long or maximum stimulus analysis time.

12. <u>Fast Rate</u> - A fast rate or speed of presentation of stimuli to the trainee, allowing the trainee a short or minimum stimulus analysis time.

<u>Frequency of Stimuli Change</u>

13. <u>Infrequent</u> - A low frequency of stimuli change, i.e., stimuli presented to the trainee change from one to another infrequently.

14. <u>Frequent</u> - A high frequency of stimuli change, i.e., stimuli presented to the trainee change from one to another frequently.

Number of Stimuli

15. Few - A small number of separate streams of signals that occur independently of each other, but require simultaneous consideration.

16. Multiple - A large number of separate streams of signals that occur independently of each other, but require simultaneous consideration.

Stimuli Format

17. Formatted - Formatted or organized stimuli, such as alphanumeric displays.

18. Unformatted - Unformatted or unorganized stimuli, such as raw video displays.

Patterning of Stimuli

19. Simple - Simple or common patterns of stimuli, such as the repetition of the same event at high frequencies of occurrence.

20. Complex - Complex, detailed, or circumstantial patterns of stimuli, such as discrete sequenced patterns at low frequencies of occurrence.

INFORMATION STRUCTURE RELATED VARIABLES

RESPONSE CHARACTERISTICS

Response Mode of Implementation

1. Overt Response - Verbal - A response which the trainee expresses in an audible (verbal) manner, such as a verbal short answer response to a question having a limited set of correct answers, a conversational response, or a verbal decision response.

2. Overt Response - Written - A response which the trainee expresses in an observable (written) manner, such as a free style written response, a written multiple choice response, or a written fill-in-the blank response.

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4. Overt Response - Tracking - A response which the trainee expresses in an observable (tracking) manner, such as continuously controlling a constantly changing system, e.g., steering an automobile.

5. Overt Response - Procedural Performance - A response which the trainee expresses in an observable (procedural performance) manner, such as performing a sequence of steps in a procedure, e.g., carrying out the items on the checklist for preflighting an aircraft or turning on a radar system.

6. Covert Response - A response which the trainee creates in his mind but does not express in an observable or audible manner.

Response Implementation

7. Static - A unitary response situation, i.e., responses are made by the trainee "all at once".

8. Dynamic-Ordered - A sequential response situation, i.e., responses are made by the trainee sequentially or in an ordered manner over time.

9. Dynamic-Random - A non-sequential response situation, i.e., responses are made by the trainee randomly over time.

Required Response Rate

10. Slow Rate - A slow rate or speed of trainee response, i.e., a rate which allows the trainee a long or maximum response time.

11. Fast Rate - A fast rate or speed of trainee response, i.e., a rate which allows the trainee a short or minimum response time.

Response Frequency

12. Infrequent - A low frequency of response change, i.e., responses made by the trainee change infrequently.

13. Frequent - A high frequency of response change, i.e., responses made by the trainee change frequently.

Number of Required Responses

14. Few - A small number of responses that the trainee is required to express, each independent of the other.

15. Multiple - A large number of responses that the trainee is required to express, each independent of the other.

Response Format

16. Formatted - Formatted responses, e.g., responses to a programmed text.

17. Unformatted - Unformatted responses, e.g., responses made by team members during an emergency situation.

Patterning of Responses

18. Simple - Simple or common patterns of responses, such as repetition of the same response at high frequencies of occurrence.

19. Complex - Complex, detailed, or circumstantial patterns of responses, such as discrete sequenced patterns of responses at low frequencies of occurrence.

INFORMATION STRUCTURE RELATED VARIABLES

INFORMATION FEEDBACK LOGIC

Medium of Feedback Presentation

1. Visual - Feedback presented visually by means of a display, it may be coded and transmitted visually to the trainee.

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7. Kinesthetic - Feedback presented to the trainee by either internal or external bodily movement, such as reaching, grasping, tilting, etc.

8. Olfactile - Feedback presented to the trainee through the sense of smell.

9. Gustatile - Feedback presented to the trainee through the sense of taste.

Time Schedule for Feedback

10. Pre-F Interval - Immediate - Feedback provided immediately after the trainee's antecedent response, i.e., there is a small or no interval of time between the antecedent response and the feedback for that response.

11. Pre-F Interval - Delayed - Feedback provided subsequently after the trainee's antecedent response, i.e., there is an interval of time or delay between the antecedent response and the feedback for that response.

12. Post-F Interval - Immediate - Presentation of the next stimulus immediately after the occurrence of feedback for the last response, i.e., there is a small or no interval of time between the occurrence of feedback for the last response and the presentation of the next stimulus.

13. Post-F Interval - Delayed - Presentation of the next stimulus subsequently after the occurrence of feedback for the last response, i.e., there is an interval of time between the occurrence of feedback for the last response and the presentation of the next stimulus.

Feedback Regularity

14. Regular - Feedback provided to the trainee at regular intervals, such as after every or every other response or at established or fixed periods.

15. Irregular - Feedback provided to the trainee at variable intervals, which may change as a function of stage of training or level of performance. This includes the provision for intermittent presentations to permit probabilistic schedules for reinforcement.

Frequency of Feedback

16. Frequent - Any feedback given to the trainee that is provided at least for 20-30% of all his responses.

17. Infrequent - Any feedback given to the trainee that is provided less than for 20% of all his responses or is not provided at all.

Feedback Format

18. Formatted - Formatted feedback, e.g., alphanumeric feedback displays.

19. Unformatted - Unformatted feedback, e.g., raw video feedback displays.

APPENDIX D

SAMPLE COST SHEETS

COST DATA COLLECTION FORM

Instructional Delivery System 16P

Run ID SAMPLE SHEET 1

SELF PACE

SYMBOL	VARIABLE DESCRIPTION	VALUE	UNITS
FACILITIES			
FACOST	Total facilities acquisition and/or refurbishing costs	175,000	Dollars
LOFFA	Expected years of life of FACOST assets (In whole numbers)	15	Years
SQFTIN	Total square feet required for each instructor	64	Sq Ft
SQFTST	Total square feet required per student position	100	Sq Ft
SQFTAH	Total square feet required for administrative overhead for all student positions	2,500	Sq Ft
EQUIPMENT			
EQCISP	Equip. implementation costs independent of stud. pos.	125,243	Dollars
LOFEQ1	Expected years of life of EQCISP assets	10	Years
EQIMPC	Equip. implementation costs per student position	565	Dollars
LOFEQ	Expected years of life of EQIMPC assets (in whole numbers)	10	Years
TSPOSD	Percent of operating time student position down	.01	Percent

SAMPLE COSTING SHEET 2

SYMBOL	VARIABLE DESCRIPTION	VALUE	UNITS
Instructional Material (IM)			
UIMD	% of TLENGH (i.e., time spent in training medium) for which new instructional material must be developed	1.00	Percent
UPDATE	% of original development cost required each year to maintain instructional material	.20	Percent
EVIH	% of original development cost remaining at end of planning period	0	Percent
CIMD	Average cost of developing one hour of instructional material	188.	Dollars
Personnel INTSPO	Instructor to student postion ratio	.20	Decimal Ratio
SALINR	Annual salary and benefits of one instructor	12,640.	Dollars
Supplies SUPPLY	Cost of expendable supplies for each student while enrolled in course	1,168	Dollars
Students STUDSL	Annual salary and benefits of one student	5,656.	Dollars
STCSTI	Average student travel cost to and from school	0	Dollars
STCST2	Average per student travel cost as a part of course	0	Dollars
Miscellaneous N	Number of years in planning period	10	Years
ARATE	Attrition rate	.04	Percent
DRATE	Discount rate	.10	Percent
WSCHOP	Weeks school operates each year	50	Weeks
TLENGH	Average time spent in training medium per student (non-recycled students)	7	Weeks
TLEGTH	Average hours per week student spends in medium	40	Hours
RCRATE	Recycle rate	0	Percent
ARCYTM	Average time the recycled student spends repeating material	0	Weeks
ESP	Percentage of excess student positions required to provide for fluctuations in input	0.05	Percent

SAMPLE COST SHEET 3

SELF PACE

SYMBOL	VARIABLE	Yr 1 Yr 11	Yr 2 Yr 12	Yr 3 Yr 13	Yr 4 Yr 14	Yr 5 Yr 15	Yr 6 Yr 16	Yr 7 Yr 17	Yr 8 Yr 18	Yr 9 Yr 19	Yr 10 Yr 20
Facilities											
CPSQFT(I)	Cost/Ft^2 for Facilities Per Year (Dollars)	3	3	3	3	3	3	3	3	3	3
Equipment											
CAQSP(I)	Equipment Acquisition Cost/Student Position	50	50	50	50	50	50	50	50	50	50
LOFEQ(I)	Expected Life of CAQSP(I) Assets (Years)	10	10	10	10	10	10	10	10	10	10
COPMT(I)	Operation and Maint. Cost of Equipment Per Student Position for Each Year (Dollars)	30	30	30	30	30	30	30	30	30	30
OMFEQ(I)	O & M Costs of Fixed Equipment (Dollars)	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Students											
UIMDYR(I)	Unique Hours of IMD Per Year (Hours)	0	0	0	0	0	0	0	0	0	0
Instructional Material											
GRAD(I)	No. of Graduates Required for Each Year (Number)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

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